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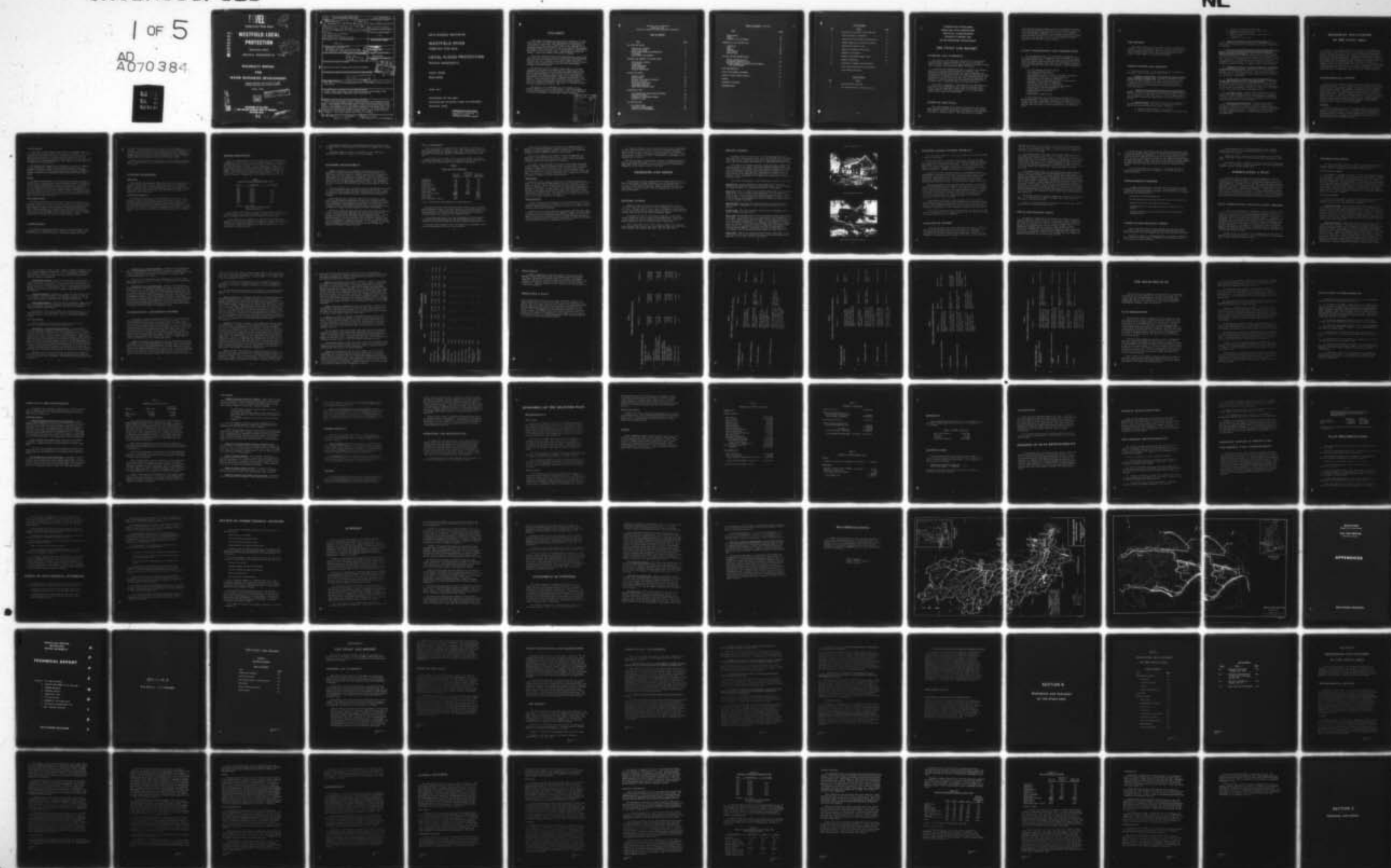

LEVEL II

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CONNECTICUT RIVER BASIN

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# WESTFIELD LOCAL PROTECTION



WESTFIELD RIVER

WESTFIELD, MASSACHUSETTS

## FEASIBILITY REPORT FOR WATER RESOURCES DEVELOPMENT

391 659

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DEPARTMENT OF THE ARMY
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This study investigated the water resource problems of the Westfield River Basin in southwestern Massachusetts and focused of the flood problem in Westfield. This growing city of 32,00 people is faced with the most serious flood threat of any community in the four-state Connecticut River Basin, due to its historic and extensive development of the flood plain. It is estimated that a recurrence of the flood of record of August, 1955 -- which caused $8 million in damages -- would today produce $100 million of damage.

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WATER RESOURCES INVESTIGATION

# WESTFIELD RIVER

CONNECTICUT RIVER BASIN

# LOCAL FLOOD PROTECTION

WESTFIELD, MASSACHUSETTS

SURVEY REPORT

MAIN REPORT

APRIL 1979

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS.

# *SYLLABUS*

This study investigated the water resource problems of the Westfield River Basin in southwestern Massachusetts and focused on the flood problem in Westfield. This growing city of 32,000 people is faced with the most serious flood threat of any community in the four-state Connecticut River Basin, due to its historic and extensive development of the flood plain. It is estimated that a recurrence of the flood of record of August, 1955 -- which caused $8 million in damages -- would today produce $100 million of damage.

Of all the structural and non-structural solutions studied, only local protection works were found to be capable of providing adequate protection up to the Standard Project Flood. Eight plans were analyzed, each one a variation of the basic system of dikes and walls, channels, gates, pumping stations and associated appurtenances proposed in previous studies.

The selected plan, 8-1/2 miles of earth dikes in a two-loop configuration with three new channels and six ponding areas, would eliminate flood damage in the most highly developed 1,700 acres of downtown Westfield lying in the flood plain of the Westfield and Little Rivers and Powdermill Brook. Total cost of the project is $39,100,000, of which $34,300,000 is Federal and $4,800,000 is non-Federal. Annual maintenance would be $20,000. With a project life of 100 years, average annual benefits would be $3,707,000 and total annual costs would be $2,980,000. The project is economically justified with a benefit-cost ratio of 1.24.

The project is not recommended, due to the absence of the required commitment for local participation. Timely establishment of an early warning system and evacuation plan by the city of Westfield is strongly recommended to protect public health and safety.

WESTFIELD LOCAL PROTECTION
WESTFIELD RIVER
FEASIBILITY REPORT FOR WATER RESOURCES DEVELOPMENT

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CONNECTICUT RIVER BASIN
WESTFIELD LOCAL PROTECTION
WESTFIELD, MASSACHUSETTS
FEASIBILITY REPORT FOR
WATER RESOURCES DEVELOPMENT

# THE STUDY AND REPORT

## PURPOSE AND AUTHORITY

The purpose of this study was investigation of the flood and associated water resources problems of the city of Westfield to develop the most suitable plan for their solution, consistent with the area's economic, social and environmental well-being.

In June 1970 the Comprehensive Water and Related Land Resources Report for the Connecticut River Basin was completed. The coordinating committee which guided that study recommended a 1980 Connecticut River Basin Plan to meet the immediate water-related needs of the basin. One element of that plan was a reauthorization of the Westfield Local Protection Project with construction essentially as previously authorized, except that the project would be modified to include the part of Westfield north of the Westfield River.

This report is submitted in compliance with the 1980 Connecticut River Basin Plan recommendation and in partial compliance with a resolution by the Committee on Public Works of the United States Senate, adopted 11 May 1962, authorizing a review of the existing reports on the Connecticut River Basin.

## SCOPE OF THE STUDY

This report presents the studies for flood control and related water resources problems for the city of Westfield in the Westfield River Basin. The city of Westfield and its location in the Westfield River Basin is shown on Plate 1. The study focuses on problems

associated with the main portion of the city of Westfield including flood control, recreation, water quality, environmental quality and social well-being of residents in the area and in the community. Flood problems were investigated and analyzed in sufficient depth and detail to permit selection of a plan of improvement consistent with the needs in the area and in accord with the plans of concerned agencies and the desires of local interests.

## STUDY PARTICIPANTS AND COORDINATION

The New England Division, U.S. Army Corps of Engineers, had principal responsibility for conducting and coordinating this study and preparing this report. During the course of the study, numerous formal and informal meetings were held with appropriate Federal and State Government agencies, local officials and interested citizens to coordinate proposals with their plans and goals. These organizations included:

- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S. Department of Agriculture
- Massachusetts Division of Fisheries and Game, Connecticut Valley Wildlife District and Field Headquarters
- Massachusetts Water Resources Commission
- Executive Office of Environmental Affairs, Massachusetts Department of Environmental Management
- Massachusetts Department of Public Works
- Board of Selectmen, West Springfield, Massachusetts
- Westfield River Watershed Association, Inc.
- Planning Board, City of Westfield
- Hampden Conservation District
- Sierra Club
- Massachusetts Audubon Society

A public meeting was held in Westfield on 18 March 1975 to present alternative flood protection proposals and solicit the views, interests and ideas of Government agencies, local residents, utility companies and other public and private interests. As a result of this meeting, additional plans for flood protection were included in the study.

## *THE REPORT*

This report consists of a main report written in nontechnical language, a technical appendix, pertinent correspondence, a cultural resources reconnaissance report, and a revised draft environmental impact statement setting forth a qualitative assessment of the project's likely impact on the natural environment.

## *PRIOR STUDIES AND REPORTS*

Flood control in the city of Westfield has been considered or discussed in the following reports since 1959:

1. Northeast Flood Studies -- Interim Report, Westfield River, Corps of Engineers, November 1959. Prepared in response to public concern following the August 1955 flood, this survey level report reviewed the flood problems of the Westfield River watershed and recommended that the authorized plan for flood control in the Connecticut River Basin be revised to include the Westfield Local Protection Project.

2. Powdermill Brook Watershed Protection and Flood Prevention Project. Prepared by the Hampden Soil Conservation District and the city of Westfield with assistance from the U.S. Department of Agriculture and completed in 1961, this report resulted in construction of the Powdermill Brook and Arm Brook projects by the Soil Conservation Service.

3. Design Memoranda. The following seven design memoranda for the Westfield Local Protection Project, as proposed in the early 1960's, have been published by the Corps of Engineers:

   1. Hydrology and Hydraulics, 31 October 1963
   2. General Design (including Site Geology), 18 December 1963

3. Concrete Materials, 9 November 1962
4. Embankment and Foundations, 12 February 1964
5. Pumping Station, 24 June 1964
6. Detail Design Walls and Miscellaneous Structures, 28 August 1964
7. Real Estate, 1 March 1964

4. Flood Plain Information Report, Westfield, Mass. This report, completed by the Corps of Engineers in 1969, delineated the flood plains for the Westfield and Little Rivers within the Westfield city limits.

5. Work Plan for Watershed Protection and Flood Prevention; West Branch of the Westfield River Watershed, Berkshire, Hampden and Hampshire Counties, Massachusetts. This report was prepared by the Massachusetts Department of Natural Resources and the Soil Conservation Districts of the Soil Conservation Service and completed in July 1969. It dealt with flooding and other water resource problems within the drainage area of the West Branch of the Westfield River and recommended the construction of 11 dams to reduce erosion and sediment production, retard floodflows and enhance recreation opportunities.

6. Comprehensive Water and Related Land Resources Investigation of the Connecticut River Basin. Completed in 1970, this report was prepared by the interagency Connecticut River Basin Coordinating Committee with the New England Division, Corps of Engineers acting as the chair agency. Improvements proposed included local flood protection in the city of Westfield.

7. Present Status of Elements for Flood Damage Reduction -- Holyoke, West Springfield and Westfield, Massachusetts. This report was prepared by the Center of the Environment of Man, Inc., for the New England Division, Corps of Engineers in 1974. It assessed the present status of flood damage reduction elements in the communities of Holyoke, West Springfield, and Westfield. The report was prepared as part of the Connecticut River Supplemental Study.

8. The River's Reach. Completed in December 1976 by the New England River Basins Commission, this report developed a regional strategy to reduce existing and future flood damage and recommended structural and nonstructural solutions for communities such as Westfield which have the most severe problems.

9. Knightville Dam Modification. Prepared by the Corps of Engineers and completed in June 1978, this report addressed the feasibility of modifying the Knightville Dam to provide storage for additional flood control, a recreational pool or low flow augmentation to enhance downstream fishing. It concluded that modifying the dam for these purposes would not be feasible, either economically or environmentally.

# RESOURCES AND ECONOMY OF THE STUDY AREA

Westfield is a prosperous, growing city. Unlike other communities in the watershed of the Westfield River, its population has grown steadily over the last quarter century. It has a diversified economy consisting of industry, commerce and agriculture. Extensive residential development radiates out from the downtown core. Recreational opportunities abound in the sparsely developed countryside surrounding the city, which enjoys a mild climate. It is accessible by major transportation modes and still has substantial amounts of undeveloped land. Westfield is the kind of community that is likely to benefit from the growing national trend toward living and working in smaller cities. Because a large portion of the city is located within the flood plain, the ever-present danger of flooding cannot help but have significant impact on the city's future prosperity.

## ENVIRONMENTAL SETTING

The Westfield River drains the fifth largest watershed in the Connecticut River Basin. It has a drainage area of 517 square miles covering a large portion of the eastern slopes of the Berkshire Hills. Located within Berkshire, Hampden and Hampshire Counties of western Massachusetts and with small portions in Franklin County, Massachusetts and Hartford County, Connecticut, its upper reaches are generally hilly with narrow, steep-sided valleys. Ridges in the headwaters rise 500 to 900 feet above adjacent valleys. In the eastern extremity of the watershed, the valley of the main stream emerges from the hilly terrain into flatter lowlands, flowing through the city of Westfield and eastward to the Connecticut River. Plate No. 1 shows a map of the watershed.

### VEGETATION

The various types of growth in the central portion of the basin are referred to as transitional forest. The warmer eastern section consists mainly of oak-hickory forest. With the exception of the southeastern industrial centers, the basin is heavily wooded with natural second and third growth forests. The damp, cool, mountainous western section is characterized by northern hardwood forests.

FISH AND WILDLIFE

Of the three streams flowing through Westfield, Powdermill Brook has the highest water quality and therefore the best fish habitat. The Little River has poor fish habitat because of substantial flow fluctuations resulting from dam operations and generally poor water quality. The Westfield River supports a warm water fishery except at its confluence with the cooler waters of Powdermill Brook. Fish habitat in the Westfield River is limited by poor water quality.

The mammal and bird populations in Westfield are typical of urbanized areas of New England. Mammals are predominantly rodents, foxes and raccoons. Larger animals such as bear and deer are found in the upper reaches of the basin. The bird population contains a normal assemblage of warblers in wooded areas and swallows, hawks and similar birds in open areas.

GEOLOGY

The Westfield River Basin lies mostly within the western highlands of Massachusetts, a rough, maturely dissected upland underlain by crystalline rocks of igneous and metamorphic origin. The eastern part of the basin is in the Connecticut Valley lowland in which the bedrock is composed of inclined sedimentary strata. In the upland, which is generally blanketed by a thin veneer of till, bedrock outcrops in numerous and extensive areas. Extensive deposits of gravel, sand, silt and clay occur as outwash plains and terraces and overlay the till or bedrock in the lowland and, to a much lesser extent, in the upland valleys.

STREAM CHARACTERISTICS

The Westfield River rises in the town of Savoy, Massachusetts, at an elevation in excess of 2000 feet above mean sea level. The river follows a generally southeasterly course for about 57 miles, entering the Connecticut River between the towns of West Springfield and Agawam, Massachusetts, about 75 miles upstream of Long Island Sound. The Westfield River has a total fall of about 2000 feet. Principal tributaries are the Little River, the West Branch and the Middle Branch. There are also a number of smaller streams such as Powdermill Brook in the Westfield River system.

## *CLIMATOLOGY*

The climate of the Westfield River Basin is generally moderate. Lower elevations in the southeastern portion experience a milder climate than high elevations to the north and west. Mean annual temperatures vary

from about 50°F in the lower valleys to about 44°F in the higher elevations. Hot and cold spells are usually of short duration, but extremes of 102°F and -30°F have been recorded. Average annual precipitation is about 46 inches, uniformly distributed throughout the year. Maximum and minimum annual precipitation at Westfield during the 71 years of record through 1976 are 70.3 inches in 1955 and 29.7 inches in 1965.

Average annual snowfall varies from 42 inches at Westfield to about 70 inches in the Berkshires. Mean annual runoff for the Westfield River is 26.12 inches.

# *NATURAL RESOURCES*

## WATER SUPPLY

More than 200,000 people draw their water from the Westfield River and, industries depend on it for their manufacturing process. The basin's largest source of water is Cobble Mountain Reservoir on the Westfield River. It supplies the cities of Springfield, Agawam and Southwick, among others. The river and its tributaries can usually meet the public and industrial needs in the basin.

## HYDROELECTRIC GENERATION

Five hydroelectric plants in the Westfield River Basin have an installed capacity of 500 kilowatts or more and a total capacity of 38,710 kilowatts. The only public utility plant in the basin is operated by Western Massachusetts Electric Company at Cobble Mountain Reservoir. It has an installed capacity of 33,000 kilowatts and a gross head of 456 feet. The other four plants are industrially owned but their supply is augmented by steam generation and the public utility during periods of low streamflow.

## *HUMAN RESOURCES*

There are 28 Massachusetts cities and towns and two Connecticut towns lying wholly or partly within the Westfield River Basin. In 1970 the estimated population of the basin was 106,845, an increase of 22 percent over the 1960 figure of 83,528. Of this, 76 percent is urban, all concentrated in Westfield, West Springfield and Agawam. Westfield, the largest municipality in the basin, had a 1975 estimated population of 32,863. Since 1960 the city's population has grown by 25 percent, and it is projected to increase by another 20 percent by 1990 to a total of 39,500. Table No. 1 documents the city's population growth since 1900.

TABLE 1
Westfield's Population Trends 1900 - 1990

| Year | Population | % of Change |
|---|---|---|
| 1900 | 12,341 | |
| 1910 | 16,044 | 30.0 |
| 1920 | 18,604 | 16.0 |
| 1930 | 19,775 | 6.3 |
| 1940 | 18,793 | -5.0 |
| 1950 | 10,962 | 11.5 |
| 1960 | 26,302 | 25.5 |
| 1975 | 32,863 | 25.0 |
| 1990 | 39,500 | 20.2 |

Sources: U.S. Census
Lower Pioneer Valley Regional Planning Commission

The remainder of the basin is sparsely populated except for the city of Holyoke, which lies only partly within it. More than 75 percent of the basin's communities have fewer than 100 persons per square mile.

Unlike similarly sized communities in this part of Massachusetts, Westfield is maintaining a substantial growth pattern while most others are experiencing a loss in population. In-migration accounted for 57 percent of Westfield's population growth between 1960 and 1970 and the rest is attributed to natural increases.

Westfield's population is overwhelmingly white--99.5 percent in 1970. Only 6.3 percent of the population was foreign born compared to 9.2 percent in 1960.

The median number of school years completed by the residents of Westfield is 12.2 which is equal to the State average.

## *ECONOMIC DEVELOPMENT*

Community settlement in the Westfield River Basin dates from the mid-1700's. Numerous rivers and streams on the eastern slopes of the Berkshires led to the erection of sawmills and gristmills thoughout the area. Paper mills and tanneries also characterized early industrial development. As the northern basin communities concentrated on dairying, poultry raising, and agriculture, industry expanded in the southeastern portion east of the rugged Berkshire terrain. There, along the banks of the lower reaches of the Westfield River, building was easy on the flood plain.

With the availability of water power sources, Westfield became a center for the manufacture of whips and cigars during the 19th century. Later, the growth of firms producing bicycles, textile machinery, wood products and precision tools continued the city's conversion from agriculture to industry.

Today, Westfield is an important industrial and commercial center within the Springfield-Chicopee-Holyoke SMSA, both drawing workers from other communities and providing homes for Westfield residents who commute to jobs elsewhere. Major employers in Westfield are in the field of electronics, electrical machinery and paper goods. Manufacturers of guns, bicycles, metal goods and other materials also provide employment.

Westfield's population growth over the past 25 years has nourished its economy. Since 1950 local jobs have more than doubled from 5,765 to 11,961, with manufacturing employment increasing by 84 percent. It now provides more than half of the private sector employment in the city. Employment growth in service industries such as finance, insurance, real estate, transportation, communications and utilities is expected to keep pace with Westfield's increasing population. It is important to note that overall employment during the last 25 years more than doubled while population increased by about 50 percent.

## LAND USE CHARACTERISTICS

Most of the land in the Westfield River watershed is undeveloped and over half is devoted to recreational uses. While agriculture is the second most predominant land use basinwide, significant concentrations of land are developed for industrial, commercial and residential uses in the southeast.

Less than half of Westfield's total area is developed. Agriculture, residential development, recreation and transportation are all major land uses. Table No. 2 details these major land uses in Westfield.

TABLE 2

Major Land Uses in Westfield

| | Land Use (acres) | Percent of Developed Land | Percent of Total area |
|---|---|---|---|
| Residential | 2741 | 19.6 | 9.0 |
| Commercial | 208 | 1.5 | 0.7 |
| Industrial | 579 | 4.2 | 1.9 |
| Transportation | 2265 | 16.2 | 7.4 |
| Recreation | 2695 | 18.6 | 8.5 |
| Public Utilities | 229 | 1.6 | 0.8 |
| Public Buildings | 157 | 1.1 | 0.5 |
| Agriculture | 5190 | 37.2 | 17.7 |
| Total Land Developed | 13965 | 100.0 | 46.0 |
| Vacant Land | 15901 | | 52.3 |
| Water Bodies | 538 | | 1.8 |
| Total area (land & water) | 30404 | | 100.0 |

Source: Lower Pioneer Valley Regional Planning Commission

Westfield has utilized the flood plain since early times. The denser urban population occurs on the flood plain west of the Westfield and Little Rivers confluence. This area is flat, easy to build on, and conducive to transportation. More than 3,100 acres of this flood plain are heavily developed residential, commercial and industrial areas.

On the flood plain east of the city, along Route 20, the development has included the large Westgate and Westfield shopping centers, other commercial and industrial buildings and about 500 multiple-dwelling units.

Well over 2,200 residential units, 400 commercial establishments and 40 public buildings make up the city's main district.

Various mineral deposits are not commercially valuable, except for deposits of carborundum and emery formerly used in the manufacture of abrasives in Chester, manganese mining in Plainfield, and intermittent quarrying in West Springfield, Westfield and Southwick.

Poor soil and rugged terrain combine to limit the importance of agriculture in the Westfield River Basin. Tobacco growing and truck farming are carried on in relatively small areas of rich, intensively cultivated land in the lower portion of the basin.

Five State forests and parks in the basin provide opportunities for fishing, hunting, camping, swimming, boating and picnicking. Extensive stocking of ponds and streams attracts sport fishermen from all parts of the State. Hunting is also popular in the large, well-wooded areas. Several hundred acres of forest reservation serve as wildlife refuges, but there is a scarcity of suitable recreational water bodies since most lakes and ponds are reserved for water supply purposes.

## TRANSPORTATION

Westfield is well situated in relation to all major transportation modes. It is served by the Massachusetts Turnpike (Interstate 90) and U.S. Routes 20 and 202. Barnes Municipal Airport is the third most active airport in Massachusetts. Its operations are dominated by corporate and business jet aircraft. Freight service is provided by the Penn Central Railroad's line between Springfield and Albany, New York and by several long-distance trucking firms. Three buslines are franchised to serve the city. Within Westfield private automobile is the principle mode of travel and the city suffers from internal congestion.

## FUTURE DEVELOPMENT

General location and environmental attractiveness make the Westfield River Basin an appealing area. Growth seems inevitable. However, while the northern communities should remain rural in character, the urban areas will probably continue their expansion.

Because of its location, character and amenities, Westfield has a very favorable potential for industrial and commercial growth. Continued growth and dispersion in the Springfield-Chicopee-Holyoke SMSA will increase the demand for housing and stimulate growth in consumer-oriented businesses. A recently completed land use inventory and analysis concludes that Westfield has enough suitable land to accommodate future growth.

The community, however, is very concerned about the type of development that will take place in the future and in 1974 a planning department was formed. Among the city's goals are a balanced diversity of industrial, commercial and residential development, preservation of agricultural land, and preservation of the flood plain. Concentration of development in the downtown area is desired.

From this analysis, it seems evident that much of Westfield's future is tied to continuing development in the flood plain of the Westfield River, where homes and businesses will continue to be subject to the hazards of disasterous floods similar to those of the past.

# PROBLEMS AND NEEDS

The major water resource problem within the Westfield River watershed is the periodic flooding of extensive areas of developed land within the city of Westfield. Related water resource problems and needs considered in this study include water quality, municipal and industrial water supply, outdoor recreation, low flow augmentation, and fish and wildlife resources.

## HISTORIC FLOODS

Damaging floods have occurred along the Westfield River and its tributaries since the founding of the first settlements in the basin in the 1700s. Although there is little reliable information on the magnitude of most early floods, records indicate that the floods of October 1869 and December 1878 were severe and caused considerable damage.

On December 10, 1878, 6 to 8 inches of snow fell on the frozen ground, followed by rain and rapidly rising temperatures. This produced an exceedingly high rate of storm water runoff and a great amount of damage thoughout the valley, and particularly in Westfield.

Other known floods prior to 1900 occurred in March 1776, September 1826, February 1840, January 1841, April 1843, May 1854, April 1862, April 1869, September 1879, January 1880, April 1895, and March 1896.

# RECENT FLOODS

Reliable records of flood stages on the Westfield River have been kept since 1909. They show that minor floods are frequent in the basin and flood stages occur in the lower portion of the basin nearly every spring, usually because of melting snow, sometimes in combination with heavy rains.

Since most of the upstream terrain is steep and hilly, rainfall and snowmelt runoff is very rapid. High water conditions develop quickly and with relatively little warning in the valleys and on the broad, flat plains on which Westfield is situated. Experience gained from regulation of the Knightville Reservoir above Westfield indicates that floods on the principle branches of the Westfield River crest about 4 hours after intense rainfall. Flood concentration in the Westfield follows heavy precipitation by about 8 hours.

Since 1927 the following six major floods have occurred in the basin:

November 1927. October rainfall was almost double the normal amount, saturating the ground and filling the streams and ponds. A flood resulted from heavy rainfall over a 30-hour period from 2 to 4 November.

March 1936. From 9 to 13 March heavy rainfall combined with relatively high temperatures to melt a portion of the snow cover. The resulting runoff broke up the ice cover on the rivers and caused serious ice jams in lower basin streams. A second rainstorm of greater intensity occurred on 18 to 19 March, melting the remaining snow cover and causing the already swollen rivers to overflow their banks.

September 1938. The second most damaging flood of record resulted from heavy rainfall accompanying a tropical hurricane which swept over New England.

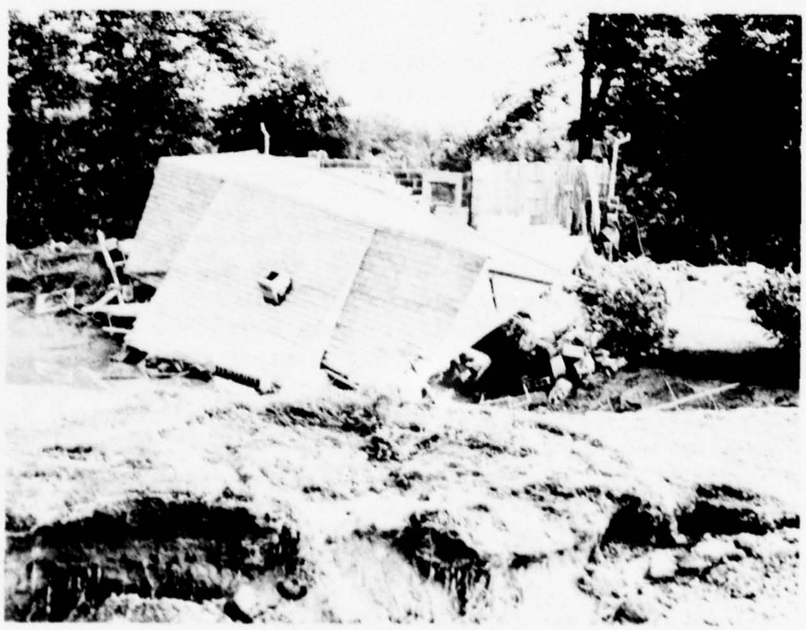
December 1948. This flood resulted from heavy rains, averaging about 9 inches, falling on frozen ground.

August 1955. This maximum flood of record was caused by three storm centers that passed over Massachusetts, one of them directly over the Westfield River Basin. Heavy rains, totaling almost 20 inches around Westfield, fell on ground already saturated by 6 to 9 inches of rain during the previous week. The Westfield flood plain was inundated by floodwaters that reached heights of 20 feet. Total flood losses in Westfield's main damage zones were estimated at approximately $8 million. About 650 dwellings, 50 commercial establishments, 7 industrial firms and 16 farms experienced flood damage. Pictures indicating typical damage are shown on Page 14.

October 1955. This is the last major flood to occur in the basin. It was caused by a slow-moving continental storm passing over New England which deposited up to 13 inches of rain in the basin.

Flood of August 1955

Along Powdermill Brook



Along Route 20 Westfield River

## EXISTING FLOOD CONTROL PROJECTS

Over the years a number of flood control projects have been undertaken to reduce flood damages.

Before 1869 the city of Westfield constructed a dike on the right bank of the Westfield River upstream of the Elm Street Bridge. The dike has been washed out or overtopped several times. After the 1938 flood it was rebuilt and extended downstream by the State. In 1955 the dike failed again by overtopping. Although it has since been repaired, it gives only limited protection to a highly developed section of Westfield.

In 1941 the Corps of Engineers completed the Knightville Dam as a single-purpose flood control reservoir; and in 1965 the Corps built Littlefield Lake, a multipurpose flood control and water supply reservoir. As part of the comprehensive plan for flood protection in the Connecticut River Basin, these projects reduce flooding at damage centers on the Westfield and Connecticut Rivers. Both projects are upstream of Westfield.

The West Springfield flood protection works consist of about 2 miles of walls and dikes along the west bank of the Connecticut River and about 3 miles along the Westfield River. Built by the Corps, this local protection project protects about 1,100 acres of highly developed industrial, commercial, public and residential property in West Springfield, which operates and maintains the project. The Corps is presently investigating the feasibility and desirability of raising the height of this system to increase the level of flood protection.

Three projects of the Soil Conservation Service (SCS), located on Black, Powdermill and Arm Brooks, small tributaries of the Westfield River, reduce flooding immediately downstream but have a minor effect on flooding along the Westfield River. SCS has also studied numerous potential sites for possible installation of flood retarding and multipurpose impoundments.

Several municipal water supply reservoirs have also been built in the basin, the largest of which is Cobble Mountain reservoir. These are usually not operated for flood control purposes.

## ANALYSIS OF FLOODS

The major floods of record in the Westfield River basin, notably the August 1955 and September 1938 events, were analyzed to determine their development and how runoff from the various parts of the watershed contributed to the total flooding effect in Westfield. Storage of these floodwaters in Westfield was also studied. The 1938 flood was caused by a

storm which was more or less centered over the entire watershed, whereas the 1955 event came about as a result of a storm centered over the lower portion of the watershed, where there is no control from the Knightville or Littleville flood control dams.

The Standard Project Flood (SPF) for the Westfield River Basin was determined from engineering and hydrological studies. The SPF is not an actual historical flooding event. Rather, it describes the conditions that would result from the most severe combination of meteorological and hydrological conditions which can be reasonably expected to occur in this particular basin. SPF designation is used to determine the degree of flood protection that should be designed into flood control works in urban areas. It has been used in all flood control studies performed to date for Westfield.

The Standard Project Storm for the Westfield River Basin was determined to have an average 24-hour rainfall exceeding 7.4 inches, with an intense 5.7 inches occurring in a 3-hour period. This would produce a very intense short duration flood event with extremely high peak runoff rates from the hilly Westfield watershed. Although the record August 1955 storm involved large volume rainfall, peak rates generally did not exceed 3 inches for a 3 hour period. In determining the SPF at Westfield for purposes of this study, it was assumed that the two existing flood control reservoirs, Knightville and Littleville, would be empty at the beginning of the Standard Project Storm and that the Knightville Reservoir would fill and discharge. The Cobble Mountain Reservoir, however, was assumed to be full at the start of the storm since this reservoir is used for water supply and hydroelectric power generation.

The 100-year flood has 1-percent probability of occurring in any given year. In the Westfield River basin, the August 1955 flood of record is equivalent to the 100-year flood.

Plate No. 2 shows the limits of flooding for the August 1955 flood of record and for the Standard Project Flood.

## *THE FLOOD HAZARD TODAY*

The important communities of the Westfield River Basin are located along the banks of the Westfield River. Large areas of these communities and the intervening lands are prone to flooding with attendant sedimentation. Most of the flood plain is within the city of Westfield in the lower reaches of the Westfield River and its tributary streams. Although substantial discharge reductions along the lower Westfield River are effected by the Knightville and Littleville Reservoirs, large areas remain flood prone. For example, extensive areas in Westfield were inundated for the first time during the flood of record of August 1955, even though the Knightville Reservoir was in operation at that time.

During the more than 20 years that have passed since the major flood of August and October 1955, the flood prone area of Westfield has undergone considerable additional development. In the more than 3,100 acres of the city that would be subjected to flooding by the Standard Project Flood, there are about 2,200 residential properties, 400 commercial establishments, 40 industrial firms, 40 public buildings, 15 farms and several major highway and rail transportation routes. The 40 industrial concerns vulnerable to flooding employ more than three-fourths of the city's industrial labor force.

It is now estimated that a recurrence of the August 1955 flood of record today would produce losses amounting to about $100 million in downtown Westfield.

## *IMPROVEMENTS DESIRED*

A public meeting was held on 18 March 1975 in Westfield to present proposed plans for the solution of the city's flooding problems. The projects were described and comments received. The consensus of the expressed desires was that there should be:

-Protection of the Union Street area;

-Minimum disruption of the existing rivers and city by the project;

-Maximum river access, both physical and visual;

-Maximum protection to real estate and land included within the project;

-Maximum recreational use of project lands and an aesthetically pleasing project.

## *OTHER WATER RESOURCE NEEDS*

Other interrelated water resource problems and needs considered in this study include water quality, municipal and industrial water supply, outdoor recreation, low flow augmentation, and fish and wildlife resources.

While water quality in the Westfield River is generally classified as Class B water, the known sources of municipal and industrial pollution are in the process of being eliminated.

Low flow augmentation of the Westfield River has been studied several times and it has been concluded that there are no economical solutions to this problem.

Fishing and outdoor recreation is fairly extensive in the basin but there is the need to improve or develop recreational opportunties in urban areas.

The quantity of water available in the basin, even with the diversion of water out of the basin to supply water needs of the city of Springfield, should be adequate for many decades ahead.

# *FORMULATING A PLAN*

Although the Westfield River Basin now has substantial flood protection from the completed Knightville and Littleville Dams and the West Springfield local protection works, a serious flood problem remains in the city of Westfield. Management of this problem is the major water resource need within the basin at the present time. An associated problem of lesser magnitude is the need to prevent the degradation of water quality as a result of flooding or of flood management measures. Accordingly, in formulating a plan, consideration was given to flood and water related problems in the area, and alternative plans were developed to alleviate these problems consistent with established planning procedure. This section describes the planning process used in developing and evaluating alternative plans.

## *PLAN FORMULATION AND EVALUATION CRITERIA*

A number of alternatives were formulated to meet the flooding problem of the city of Westfield. The first criteria for any alternative is its ability to essentially solve the flood management problems of the area. Each surviving alternative must then be evaluated for its effects on economic development and for its social and environmental impacts. In addition, each alternative must be evaluated on the basis of its cost in relation to resulting benefits as measured by the reduction of future flood damages. Any acceptable alternative must improve the quality of life in the study area through contributions to the objectives of National Economic Development (NED) and Environmental Quality (EQ), in accordance with the Principles and Standards for Water Resources Planning and Related Resources established by the U.S. Water Resources Council.

Finally, before any alternative can be implemented, it must gain the approval of local interests who must agree to make available any non-Federal project funds required by Federal statutes.

# POSSIBLE SOLUTIONS

In order to properly evaluate the impacts of proposed project alternatives, they must be compared to those impacts which would result if no action is taken to manage the flood problems outlined above.

THE "NO ACTION" ALTERNATIVE

The primary consequences of no action would be the continued economic loss and danger to human life from flooding in Westfield. Property values in the floodprone area will be relatively lower due to the flood threat, with resulting lower resale value to property owners and lower tax revenues to the city of Westfield. As stated earlier, a recurrence of the record August 1955 flood could result in damages of $100 million in 1978 dollars as well as the public inconvenience and danger of not being able to obtain necessary food, shelter, police and fire protection, and health services. Flooding will continue to obstruct pedestrian and vehicular traffic. Environmental impacts of no action would include the destruction of some fish, animal and plant life by periodic flooding.

NONSTRUCTURAL MEASURES

There are a large number of nonstructural measures for reducing flood damages. These fall into five categories: regulation, management, subsidization, acquisition and miscellaneous measures.

Regulatory measures - Such measures include zoning, building codes, health regulation, channel lines and flow regulations. In Westfield the most effective of these would be zoning and building codes. Such regulatory measures could eliminate future development in the flood plain or restrict future development to those structures and activities that would withstand flooding. Such measures do not eliminate flooding but rather mitigate its future adverse effects. They do nothing to reduce damage to existing development in the flood plain, which is the single most serious flood problems in Westfield at the present time.

Management measures - Flood forecasting and early warning, temporary evacuation, flood proofing of structures in the flood plain, land use planning and land treatment are all management techniques. The single most effective management action which the city of Westfield could implement immediately is the establishment of a flood forecasting and early warning system to alert citizens of an impending flood so that effective evacuation could take place. This is particularly important here because so much of the city is vulnerable to serious flooding and so little time is available between the occurrence of a flood-producing storm and the arrival of floodwaters. Temporary floodproofing and other actions to minimize property damage depend on such an early warning system if they are to have any effectiveness. Permanent floodproofing requires actions which citizens

are often unwilling or unable to take. Land use planning and land treatment are long-range management measures which must be practiced diligently for long periods of time, over the entire area of the watershed, in order to mitigate effects of future floods. They can provide little protection to existing flood plain development.

Subsidization measures - These include tax relief, flood insurance and incentive payments. Such measures help to insure wise use of the flood plain in the future, particularly on undeveloped land. Flood insurance can provide some relief to property owners already in the flood plain and discourage future flood plain development. None of these measures can prevent flooding in Westfield or reduce flood damages to existing flood plain development.

Acquisition measures - Acquisition consists of actually buying land in the flood plain, either developed or undeveloped, to reduce or eliminate flood damages. This is obviously a very expensive solution and, in the concentrated downtown area of Westfield, completely impractical.

Miscellaneous measures - These include tax adjustments, legal controls such as deed restrictions, and long-range techniques such as research into improved management techniques and public education on the dangers of flooding and how to prevent them.

Nonstructural flood control measures are obviously important in the long-term effort to reduce and prevent floods. Some can be implemented immediately, and at relatively little cost, an early warning system for example.

STRUCTURAL MEASURES

Three alternative structural flood control solutions for the Westfield River Basin were considered in this study.

Alternative 1 - Upstream Storage Reservoirs. The possibility of increasing upstream storage of floodwaters by expanding the capacity of existing reservoirs or building new ones was investigated, but no feasible solutions were found. Although the Cobble Mountain reservoir controls a large portion of the Little River Basin, it was designed as a water supply reservoir and cannot be relied upon to control flood waters. Modification of this reservoir to provide effective flood control storage would not be feasible. The cost of additional storage capacity in the existing Knightville Reservoir could not be justified when compared to the costs and benefits of a local protection project in Westfield. Modifications to the existing dams at Woronoco and Russell would require the relocation of U.S. Route 20, a railroad track and several towns upstream, and have serious social impacts. A proposal for a high dam at Huntington was discarded for the same reasons.

Upstream storage on the Little River at a proposed Horton Dam and Reservoir was found to be economically unjustified, having a benefit-cost ratio of less than 1.00. Furthermore, its social and economic impacts would be enormous.

Alternative II -- River Improvements. Downstream river improvements such as removing channel constrictions and deepening the channels were studied and discarded because they would substantially worsen flood problems of downstream communities and require improvements in existing flood protection works there as a result.

Diversion of the Little River was investigated and found to inadequately protect Westfield, and to require the construction of significantly higher dikes there.

Alternative III -- Local Protection. Raising of existing dikes in Westfield and the construction of new ones were found to be the most practical solutions to the Westfield's flooding problems. The portion of the city lying on the south or right bank, including manufacturing plants, commercial and residential properties, and rich farmlands, could be protected by raising the existing dike and extending it along the Little River and by straightening channels of the Little and Westfield Rivers. Development on the north or left bank, which is vulnerable to flooding, could be protected by construction of dikes and floodwalls extending from upstream of the Elm Street Bridge downstream about 6,000 feet, then turning and paralleling Powermill Brook upstream about 7,000 feet to tie into high ground upstream of the North Elm Street Bridge over Powdermill Brook.

## *ALTERNATIVES CONSIDERED FURTHER*

Of the three structural alternatives considered -- upstream storage, river improvements and local protection with walls and dikes -- only the latter warranted detailed study, in combination with the nonstructural measures of flood insurance and flood plain zoning. A total of eight plans for the local protection alternative were developed in detail to arrive at a flood protection plan that would satisfy the objectives of National Economic Development (NED) and Environmental Quality (EQ). These plans consist of various combinations of dikes, concrete walls, new channels, pumping stations, street and railroad gates, gated and ungated pressure conduits, highway bridge, sandbag structures, highway and utility relocations, and a storage area required for the construction. Table No. 3 summarized the various combinations for each of these eight plans.

Plan 1 is essentially the same plan as the one developed in the Corps of Engineers General Design Memorandum dated December 1963. The protection would consist of an earth dike beginning on the right bank of the Westfield River north of Russell Road (Route 20) and continuing downstream past Elm Street to the Chapman Playground area. At this point, a relocated Westfield River channel would begin and follow through generally open land to meet the existing river channel. The dike would then continue across Route 20 to meet the relocated Little River channel and continue westerly along the left

bank of the Little River across Southwick Road, ending at the Stevens Paper Mill dam at Crane Pond. The heights of the earth dikes -- and concrete walls where space limitations require them -- would be about 14 to 17 feet, with a top of dike width of 10 feet.

This plan would protect Westfield's core city against the damage caused by the overflow of the Westfield and Little River. It would contribute most to the national economic development and is thus considered the NED plan.

In 1965 this plan was presented to the public in a referendum and was defeated since it did not protect the northern Union Street area of the city.

Plan 2 expands Plan 1 to include protection for the Union Street area between the Westfield River and Powdermill Brook. An earth dike would extend from downstream of the Elm Street Bridge along the left bank of the Westfield River and then north along the right bank of Powdermill Brook and the relocated channel, ending east of Elm Street. This dike would average 14 to 15 feet in height. While answering the objection made to Plan 1, this plan is technically unacceptable because in the process of increasing protection to downtown Westfield it increases downstream flood stages, threatening existing properties and affecting the existing West Springfield Local Protection Project. In addition, the environmentally adverse effects of filling and abandoning the existing river channel and constructing new channels were opposed at a public meeting where the alternative was presented in March 1975. Consequently, this plan was eliminated from further consideration.

Plan 3 was developed in response to the problems and concerns expressed about Plan 2. It would retain the existing channels of the Westfield and Little Rivers and Powdermill Brook, except for a 1,600-foot channel relocation of Powdermill Brook east of Elm Street. Two dike systems would be essentially the same as in Plan 2, and a third dike would be constructed from the north side of Munger Hill along the right bank of the Little River to its junction with the Westfield River, continuing downstream along the right bank of the Westfield River to meet high ground on the east side of Munger Hill. This is a considerably more expensive plan than Plan 2 since it has more than a mile of additional dike construction. With no river relocations, the plan is the least disruptive to the existing environment. At a March 1975 public meeting the plan was found to be unacceptable due to its high costs and the division of the city into segments, with the resulting loss of mobility and business activity. Because of its cost and public opposition, it was dropped from further consideration.

Plan 4 has some of the components of Plans 2 and 3 that were acceptable to the public and would not have significant negative impacts. The protective dikes and walls of Plan 4 are essentially the same as the configuration in Plan 2. The core downtown area, including Union Street, would be protected. There would also be considerably less river channnel relocation or improvement to the Little River channel. Relocation of one dike

system would provide more favorable aesthetic, social and environmental conditions. This plan was also presented in the March 1975 public meeting and was found unacceptable for economic, environmental and aesthetic reasons. It was eliminated from further consideration.

Plan 5 was developed to meet several objections to Plan 4. One was the criticism that visual and physical access to the river would be restricted by the dikes. In this plan the dikes in two lightly developed areas would be built farther from the river. This would leave two large open land spaces between the dikes and the river channels. Plan 4 had been criticized for its lack of protection of an industrially zoned tract, which the dike would divide in half, this plan calls for placing the Union Street dike farther back from the river northerly to the railroad tracks. Major changes are also made in the larger dike system. As a result of these changes, a smaller section of Westfield's core area would be protected and prime farmland would have to be taken for construction of the dike. Because of economic implications of taking prime land which would reduce land values and tax revenues, this plan is not locally acceptable.

Plan 6, essentially a modification of Plan 4, attempts to protect the largest area of downtown Westfield with dikes and walls, but it also protects the industrial tract which was bisected in Plan 4. The windfall benefits of including this land within the protected area, would increase the local share of the cost, and the public objection to this plan.

Plan 7 is an effort to combine the desirable features of Plans 5 and 6 while minimizing the negative impacts. It leaves the Westfield and Little Rivers in their existing channels and relocates the Union Street dike away from the industrially zoned tract of land. The configuration of the protective walls and dikes is essentially the same as that in Plan 2. The exact proposed locations of these protective works is described in the Technical Appendix, Section E.

The advantages of this plan include flood protection for the enclosed downtown area against the Standard Project Flood with very little need for nonstructural measures such as flood insurance and flood plain zoning regulations. It ameliorates public objections expressed about other plans. By moving back the dikes as far as possible from the river, it also increases the floodwater storage capacity of the river outside the protective works.

Disadvantages include a slight increase in flood stage downstream, which would have to be mitigated, and the cost to the community of providing lands, easements and other items of local cooperation. Plan 7 is also the Environmental Quality (EQ) plan for the Westfield River.

Plan 8 was formulated because of Plan 7's higher cost. It provides essentially the same protection, except at the eastern end of the project. Plan 8 meets the criteria of National Economic Development, Environmental Quality and the interests of the area. Plan 8 was formulated in an orderly progression from previous plans, satisfying objections and retaining benefits. Plan 8 is economically feasible with a benefit-cost ratio of 1.24 to 1.0 and is the selected plan of this study. A system of accounts for this plan appears in the Technical Appendix and is summarized in Table 4.

TABLE 3

FEATURES OF LOCAL PROTECTION ALTERNATIVES

| Feature | Unit | Plan Number 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Earth Dike | Length in Feet | 30,900 | 42,900 | 50,900 | 46,200 | 44,000 | 53,400 | 40,200 | 39,000 |
| Concrete Wall | Length in Feet | 2,500 | 4,300 | 10,400 | 4,100 | 4,300 | 4,500 | 2,600 | 3,700 |
| New Channel Excavation | Length in Feet | 16,900 | 18,500 | 1,600 | 14,000 | 16,000 | 15,800 | 11,900 | 11,900 |
| Existing Channel Abandoned or Filled | Length in Feet | 15,500 | 17,500 | 1,500 | 6,000 | 12,000 | 9,000 | 7,000 | 7,000 |
| Pumping Station | Each | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| Street Gate | Each | 2 | 6 | 9 | 6 | 6 | 6 | 5 | 5 |
| Railroad Gate | Each | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Gated Conduit | Each | 5 | 5 | - | 1 | 5 | 2 | 7 | 7 |
| Ungated Conduit | Each | 1 | 1 | - | 2 | 1 | 2 | 1 | 1 |
| Pressure Conduit | Each | - | - | - | 1 | - | 1 | 2 | 1 |
| New Highway Bridge | Each | 1 | 1 | - | - | 1 | - | - | 1 |
| Sandbag Closure Structure | Each | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 2 |
| Interior Drainage Ponding Area | Each | 5 | 6 | - | 4 | 6 | 5 | 6 | 6 |

### Summary Comparison

A summary comparison utilizing the system of accounts including National Economic Development (NED); Environmental Quality (EQ); Social Well Being; and Regional Development (RD) was developed. The summary comparison, Table No. 4, displays the beneficial and adverse effects of the economic, environmental and social impacts assoicated with the various alternatives. Under the summary the local protection alternative Plans 1, 7 and 8 are presented.

## SELECTING A PLAN

Plan 1 has the lowest first cost of any plan considered. However, the large unprotected area of Union Street made this plan unacceptable to the public. Plan 2 also has a low first cost, however, this plan would abandon the existing river channels within the protected area leaving them dry. This was aesthically, socially and environmentally unacceptable to the public. Plan 8 is primarily Plan 2 with provisions added to provide flow in the existing river channels within the protection and best meets the desires of the community. Consequently, it was judged that the intangible environmental, social, and aesthetic advantages of Plan 8 would offset its cost and it was chosen as the Selected Plan.

TABLE 4

SUMMARY COMPARISON OF ALTERNATIVE PLANS

| | PLAN NO. 1 | PLAN NO. 7 | PLAN NO. 8 |
|---|---|---|---|
| (1) NATIONAL ECONOMIC DEVELOPMENT (NED) | | | |
| A. PROJECT FIRST COSTS | | | |
| Federal | $20,100,000 | $44,700,000 | $34,300,000 |
| Non-Federal | 4,000,000 | 4,000,000 | 4,800,000 |
| TOTAL | 24,100,000 | 48,700,000 | 39,100,000 |
| B. FLOOD DAMAGES | | | |
| Average Annual Flood Damages | $ 4,331,000 | $ 4,331,000 | $ 4,331,000 |
| Annual Residual Damages | 1,041,100 | 881,100 | 881,100 |
| Annual Flood Damage Reduction | 3,289,900 | 3,449,900 | 3,449,900 |
| C. AVERAGE ANNUAL BENEFITS | | | |
| Flood Damage Prevention | $ 3,341,800 | $ 3,462,600 | $ 3,462,600 |
| Location Benefit | 38,800 | 146,500 | 146,500 |
| Affluence Benefit | 100,200 | 111,300 | 111,300 |
| Negative Benefits | -51,900 | -12,700 | -12,700 |
| TOTAL BENEFITS | 3,428,900 | 3,707,700 | 3,707,700 |
| D. AVERAGE ANNUAL COST | 1,840,000 | 3,718,000 | 2,980,000 |
| E. BENEFIT COST RATIO | 1.82 | 1.00 | 1.24 |

TABLE 4

SUMMARY COMPARISON OF ALTERNATIVE PLANS (Cont'd)

| (2) ENVIRONMENTAL QUALITY (EQ) | PLAN NO. 1 | PLAN NO. 7 | PLAN NO. 8 |
|---|---|---|---|
| A. AIR QUALITY | Moderate increase in dust levels (particulates) during construction. | Same as Plan 1 | Same as Plan 1 |
| B. ARCHAEOLOGICAL PROPERTIES | Impact on known archaeological resources could be significant. | Impact could be slightly more than Plan 1. | Similar to Plan 7. |
| C. BIOLOGICAL RESOURCES | Slight disruption of fish and wildlife habitat within project area. Conversion of wooded and open land to a grassed dike. | Same as Plan 1. | Same as Plan 1. |
| D. NATURAL AND MANMADE RESOURCES | Commits large amounts of natural and manmade materials to project while protecting a highly developed urban center that would have been damaged or destroyed by future floods. | Commits more resources than Plan 1 but also protects more area. | Same as Plan 7. |

TABLE 4

SUMMARY COMPARISON OF ALTERNATIVE PLANS (Cont'd)

| | PLAN NO. 1 | PLAN NO. 7 | PLAN NO. 8 |
|---|---|---|---|
| (3) SOCIAL WELL BEING (SWB) | | | |
| A. AESTHETIC VALUE | Increases open space. Temporary disruption of aesthetics during construction and permanent visual impact of structure after construction. | Larger scale impact than Plan 1. | Similar to Plan 7. |
| B. NOISE | Temporary increase in noise levels during construction. | Same as Plan 1. | Same as Plan 1. |
| C. DISPLACEMENT OF PEOPLE | Project implementation requires relocation of people and structures but eliminates the need to relocate during and after flooding. | Impact slightly greater than Plan 1. | Impact slightly greater than Plan 1. |
| D. COMMUNITY COHESION | Temporary neighborhood disruption during plan implementation but no permanent disruption. | Same as Plan 1. | Same as Plan 1. |
| E. LIFE, HEALTH AND SAFETY | Reduces threat to life, health and safety during and after flooding. | Same as Plan 1. | Same as Plan 1. |

TABLE 4

SUMMARY COMPARISON OF ALTERNATIVE PLANS (Cont'd)

| | PLAN NO. 1 | PLAN NO. 7 | PLAN NO. 8 |
|---|---|---|---|
| F. PUBLIC FACILITIES AND SERVICES | Provides protection to these facilities and insures continuity of services. | Same as Plan 1. | Same as Plan 1. |
| G. LOCAL DESIRES | Object to realignment of river and desire more urban area be protected. | Satisfies objections to Plan 1. | Object to open channel along Little River. |
| H. DESIRABLE COMMUNITY GROWTH | To agree with long range land use plans, locals desire more urban area be protected. | Agrees with long range land use plans. | Open channel along Little River interferes with land use plans. |
| I. TRANSPORTATION | Causes traffic disruption during construction but protects transportation routes during future flood events. | Causes more traffic disruption than Plan 1, but protects more transportation facilities. | Same as Plan 7. |

TABLE 4

SUMMARY COMPARISON OF ALTERNATIVE PLANS (Cont'd)

| | PLAN NO. 1 | PLAN NO. 7 | PLAN NO. 8 |
|---|---|---|---|
| (4) REGIONAL DEVELOPMENT (RD) | | | |
| A. TAXES AND LOCAL GOVERNMENT EXPENDITURES | Reduces expenditures for flood fighting and repair of damaged facilities. Could also increase property values and business activity. | Same as Plan 1 but reduces expenditures further by protecting more area. | Same as Plan 7. |
| B. DESIRABLE COMMUNITY AND RECREATIONAL GROWTH | Provides potential for increased industrial and and recreational growth. | Same as Plan 1. | Same as Plan 1. |
| C. EMPLOYMENT | Increases employment during construction and safeguards jobs within protected area. | Same as Plan 1 but more extensive. | Same as Plan 7. |
| D. DISPLACEMENT OF FARMS | The edge of some farm land will be taken for the dike. | Similar to Plan 1 but additional land will be taken. | Same as Plan 7. |
| E. INCOME | Expenditures by construction workers will increase the net income of the area. Provides a market for construction materials. | Same as Plan 1. | Same as Plan 1. |

# THE SELECTED PLAN

The preceding section summarized plan formulation and identified the plans with the best potential for resolving the problems and needs of the area. The following paragraphs describe the selected plan, present information on the effects of the plan, and present design, construction, and operation and maintenance information required to understand the technical aspects of the plan.

## PLAN DESCRIPTION

The areas that would be completely protected against the standard project flood lie south of the Westfield River and north of the Little River and in the Union Street area located south of Powdermill Brook and north of the Westfield River. (See Plate 2). The protective works consist of two loops of earth dikes supplemented by concrete walls where space limitations require. The dikes would have a total length of about 39,000 feet: 14,300 feet along the right bank of the Westfield River and its overflow channel, 12,000 feet along the left bank of the Westfield River and the right bank of Powdermill Brook, and 12,700 feet along the left bank of the Little River and its overflow channel.

Three new channels would be excavated; a length of Powdermill Brook just downstream of North Elm Street would be rerouted into a 1600 foot channel to eliminate two sharp bends in the present channel; a new 2,500 foot channel across the oxbow of the Westfield River would be used as an overflow channel to carry river flows in excess of twice the annual flow; and a new 4,000 foot overflow channel would by excavated for the Little River. A section of Powdermill Brook would also be put into an 850 foot concrete pressure conduit upstream of the Sterling Radiator building.

About 3,700 feet of reinforced concrete wall would be required: 1,400 feet along the right bank of the Westfield River, 2,100 feet along the left bank of the Little River and its new channel, and 200 feet along the left bank of the Westfield River.

Five street gates would be required where the project alignment crosses existing roadways: one within the Little River dike section, the second within the Westfield River dike section, and the other three within the Powdermill Brook dike section.

Two sandbag structures would be needed where the protective works cross the north-south alignment of the existing Penn Central rail line, one on the right bank and the other on the left bank of the Westfield River. A railroad gate would be required where the dike on the left bank of the Westfield River crosses the east-west line of the Penn Central.

Two pumping stations would be required, one on the left bank of the Westfield River east of the oxbow, and the other at the eastern end of the Union Street area protective work.

Seven gated conduits would be necessary: four in the storage areas within the protective works that lie between the right bank of the Westfield River and the left bank of the Little River, one where the dike crosses the existing Little River channel; and the other two where the dike crosses the existing Westfield River oxbow. An ungated conduit would be required in the Little River channel about 1,000 feet upstream of the Penn Central railroad bridge crossing of the Little River.

Six ponding areas would be provided: two within the area protected by the Westfield River dike, three within the area protected by the Little River dike; and one within the Union Street area. These ponds would store interior runoff during times of high river stages.

The project would require the relocation of electric transmission and distribution lines and gas, water, telephone and sewer lines as well as the replacement of a portion of Route 187 (Little River Road). A highway bridge would be built where that road crosses over the new Little River channel at the east end of the project.

A total of 228 acres of land would have to be provided by the city of Westfield for the permanent easements required to build the project. It is estimated that the entire project would take 3 years to complete. However, construction at any given location would not exceed one year.

Construction of the Westfield Local Protection Project would raise the flood stage downstream of Westfield. This effect must be mitigated. Efforts would include raising the dikes in West Springfield by about 2 feet, possible reduction of assessed value of property not protected and other local measures. Plate No. 2 shows the selected plan.

# *EVALUATED ACCOMPLISHMENTS*

The selected plan for flood protection in the city of Westfield would provide the following beneficial effects:

1. Eliminate flood damage in about 1,700 of the 3,100 acres of the city of Westfield that would be inundated by the Standard Project Flood. This protected area is highly developed and contains more than 2,200 residential properties, 400 commercial establishments and 40 public buildings. Most of the remaining 1,400 acres that would not be protected by the project are agricultural or open land. Only about 20 residential and commercial properties along Union Street and Route 20 would remain subject to flooding.

2. Protection against injury and loss of life in any future flooding event, thus providing for the health and safety of citizens.

3. Protection against discontinuity of daily living, industrial and commercial activity, and the community's educational process that any future flood would cause.

4. Maintenance of the Westfield and the Little Rivers' flow in their existing channels, a desire strongly emphasized by local interests.

5. Protection against the disruption of automobile and railroad transportation activity in any future flood.

6. Creation of six ponding areas, which could be used for picnics and playgrounds when dry, and a roadway on top of the dikes which could serve as a bicycle path, jogging track and rest and scenic viewing areas.

7. Elimination of the cost and inconvenience of clean-up and rebuilding after flood events. This accrues to the benefit of both those who live and/or work in the protected area as well as other citizens of Westfield.

# *EFFECTS ON THE ENVIRONMENT*

To determine the environmental impacts of the selected plan, the Corps of Engineers consulted with numerous Federal, State and local agencies and interests. Nine impacts were identified, of which two are considered significant.

## SIGNIFICANT IMPACTS

Increased flooding outside the area of protection. At the present time floodwaters are stored in the streets and structures of downtown Westfield until the flood subsides. If the protective works are built, this storage area will no longer be available, and the floodwaters will have to go somewhere else. During a Standard Project Flood, which the local protection project will be designed to withstand, flood stages upstream from Westfield will be 3 feet higher than they would be without the local protection project. Downstream of the project the flood stages will be 2 feet higher and would diminish to normal flood stage at the Agawam Bridge in West Springfield.

Between Westfield and Agawam about 7 homes and 23 businesses (including a trailer park) would be subjected, under the worst conditions, to property damage of about $12,700 on an average annual basis.

The city of West Springfield would experience increased flood stages and, under an optimum plan, the sections of dike between the Agawam Bridge and the upstream end of the dike would be raised about 2 feet.

The movement of construction materials -- estimated to be about 3.1 million cubic yards of clay, sand, gravel and riprap -- could disrupt traffic in Westfield, create increased noise, dust and carbon monoxide levels and possibly destroy certain roads. Table 5 shows the estimated amounts of the different materials needed to construct the dikes and the estimated number of round trip truck trips required.

TABLE 5

CONSTRUCTION MATERIALS TRIPS

| Material | Cubic Yards | Estimated Round Trips |
|---|---|---|
| Clay | 2,000,000 | 100,000 |
| Sand & Gravel | 840,000 | 42,000 |
| Riprap | 217,000 | 10,850 |

The clay would be excavated from a new pit located between Fowler and Sackett Roads near the Southwick town line. For the estimated 100,000 round trips, it is planned to use Sackett and Fowler Roads as one way streets for hauling, with about 50,000 trips over each road. The entire 100,000 trips would move along City View Road and onto South Maple. At this point, about 87,200 trips would be diverted to an access road paralleling the proposed dike along the Little River. Access roads and temporary crossings over the Little and Westfield Rivers would be required. About 13,800 round trips would move along South Maple, Pleasant, Elm and Franklin Streets. Also, Mainline Drive and small portions of East Main Street and Little River Road would be used.

While total construction time is estimated at 3 years, each section of the dikes would be completed in less than one year so the roads would not be used continually for the entire construction period for hauling clay.

Sources of sand, gravel and riprap have not yet been identified, so no exact truck routes can be given at this time for hauling these materials. To alleviate congestion, the dikes and access roads would be used as much as possible.

Dust from moving the construction materials would be kept down by showering trucks and covering the load. Streets could also be swept, if necessary. All equipment would be required to meet State and Federal standards for noise abatement. The U.S. Environmental Protection Agency may require a monitoring program during construction for carbon monoxide levels. The Corps of Engineers and its contractors would comply with any standards of air quality thus imposed.

Fowler, Sackett and City View Roads are not designed to support heavy loads so it is likely that the truck trips will reduce these roads to unacceptable conditions. The Corps' contractor would be required to maintain the roads during hauling and rebuild them after completion of hauling operations.

## LESSER IMPACTS

Impacts of polluted storm water drainage. Small reaches of the Little and Westfield Rivers would be closed off from the main channels during some floods. Polluted storm water from urban areas of Westfield and discharges from two combined storm sewers would flow into these interior channels, causing three potential problems:

a) Some aquatic organisms could succumb to the direct contact with pollutants;
b) Organic materials and chemicals in the drainage could reduce the supply of oxygen in the closed off sections of the rivers:
c) A buildup of deposits could occur in these interior channels.

It is not possible to predict the exact organisms kill as a result of these impacts because it depends on the concentration of pollutants and the retention time of the floodwaters.

Another possible impact would be the potential loss of dissolved oxygen due to decomposition of organic matter in these enclosed waters with a resulting kill of organisms that depend on dissolved oxygen. Since a buildup of debris and organic material within the closed sections of the rivers could occur, the project would be designed to allow flushing action during the spring freshets to keep the channel clear.

Impact on the Westfield River's ability to purify itself. This is known as a stream's assimilative capacity and it is affected by four factors: pollutants, water temperature, dissolved oxygen and flow time. Only one of these factors -- flow time -- would be changed by the project. Hydrologic studies indicate that the change caused by the project would be inconsequential.

Impact on wildlife habitat. Loss of natural terrestrial and aquatic wildlife habitat would be significant since the proposed project would impact only a small portion of the total habitat in the Westfield River Basin. Changes in types of habitat would also occur. Potential impacts would be mitigated by plantings on dikes, adjacent areas and in construction materials borrow areas.

Impact on stream erosional patterns. In those areas of the project where increased erosion potential could occur, stream banks would be protected by riprap, thus rendering any impacts minimal.

Impacts on industrial development and river views. A potential exists for industrial development of open land behind the dikes and

for a loss of views of the rivers, if the project is built. Local citizens must decide if these impacts are justified to protect the city against devastating floods.

Impact on 29 identified cultural resources sites. Adverse impacts to these sites, which were identified during a reconnaissance survey (described in Appendix 3), may occur during construction or operation of the project. An intensive survey would be conducted prior to construction to determine procedures for minimizing construction to determine procedures for minimizing adverse impacts to the sites.

## *OTHER EFFECTS*

While the social impacts and indirect economic effects are generally intangible and not capable of precise measurement, they can be identified, described and ranked according to degree of impact expected to result.

Negative impacts include the relocation of several structures near Little River Road and Route 20, the obstruction of a shopping center, change in the character of the immediate neighborhood from a comfortable residential-commercial community to a barren channel, abrupt demarcation between protected and unprotected areas by a 12 foot wall, disruptions during construction, and others.

Positive impacts include the flood protection offered by the project, increased construction employment and resulting economic activity, higher land values and tax revenues, and removal of restrictions on development of land within the protected area.

## *DESIGN*

The Westfield Local Protection Project is designed to protect 1,700 acres of highly developed flood plain from the Standard Project Flood on the Westfield and Little Rivers and Powdermill Brook, as modified by the existing Knightville and Littleville Reservoirs.

Using a system of dikes and walls, street gates, pumping stations, improved river channels, overflow channels and ancillary structures, the rivers' floodwaters will flow through existing and overflow channels while the river channels maintained inside the dikes will collect interior drainage. In addition, an interior drainage system of storage ponds and pumping stations will handle flash floods from a 20 year frequency rainfall coincident with flood stages similar to those of the August 1955 flood of record. A detailed description of the hydrology and hydraulic design is provided in Section D of Appendix 1.

Design of dike and wall foundations and materials selected is in accordance with a detailed study of the geology of the region as set forth in Section F of Appendix 1. All materials to be used are found within a 15 mile radius of the project. Structural design is in accordance with the most recent design criteria. No unusual design problems are expected.

## *OPERATION AND MAINTENANCE*

The operation of the project would consist essentially of a warning system, gate and conduit closure, pump operation and continuous inspection during emergencies. The short warning time caused by very rapid runoff from the steep upstream watershed necessitates an adequate system of flood forecasting and early warning to make sure the project would be fully operational for maximum flood protection. Pumps would operate as interior runoff accumulates within the projected area. As the flood stage rises, other aspects of the project would come into operation.

The implementation of an early warning system for Westfield is an urgent priority whether or not the project is built.

# ECONOMICS OF THE SELECTED PLAN

## METHODOLOGY

### PROJECT COSTS

Project costs consist of first costs and annual charges over the estimated 100-year life of the project. The Federal Government would bear the total construction cost of local protection, while local interests would bear the cost of land acquisition, easements, rights-of-way and relocations necessitated by the project. Maintenance and operation of the project after completion would also be a local responsibility, in accordance with regulations and guidelines provided by the Corps of Engineers.

The value of all goods and services used in the project is estimated on the cost side. Unit prices used in estimating construction and relocation costs are based on average bid prices for similar work in the same general region. These prices are adjusted to the 1978 price level. Valuation of property reflects recent sales in the area. Land costs are based on estimated fee value.

All estimates include a 20 percent allowance for contingencies. The costs for engineering and overhead are estimated lump sums based on knowledge of the site and experience on similar projects.

Annual charges are based on an annual interest rate of 6-7/8 percent for both Federal and non-Federal costs, with amortization of the project costs distributed over the 100-year period. Allowances are also made for operation, maintenance and interim replacement of equipment.

### PROJECT BENEFITS

Project benefits are calculated primarily on the basis of present and future damages prevented by the project. Benefits also include an estimate of the increased value of protected flood plain lands (locational benefits) and of the contents of residential units protected, assuming that these contents increase in value as the incomes of the residents increase (affluence benefits). The assessment of damages prevented is based on flood damage surveys which

provide dollar estimates of both physical and nonphysical losses correlated to various stages or elevations of flooding. These actual losses are related to stage-frequency data to calculate expected losses on an annual basis. Annual benefits are then computed by subtracting total annual losses which would occur with the project from the total losses that would occur without the project.

BENEFIT-COST ANALYSIS

Benefit-cost analysis relates the annual benefits of a project to its annual costs. To be recommended for Federal participation, a project of this nature must return annual benefits in excess of its annual costs -- a benefit-cost ratio greater than 1.0 -- when benefits are divided by costs.

# COSTS

Table 6 summarizes Federal and non-Federal first costs. Total estimated project first costs are $39.1 million. This included estimated non-Federal first costs of $4.8 million. Table 7 summarizes total Federal and non-Federal investments, which include interest costs during the 3 year construction period. These investments are $37.8 million and $5.3 million respectively, for a total investment of $43.1 million. Table 8 summarizes estimated annual costs, totaling $2.98 million.

TABLE 6

## SUMMARY OF ESTIMATED FIRST COSTS

| | |
|---|---|
| **FEDERAL COST** | |
| CONSTRUCTION COST | |
| Earth Dikes | $13,000,000 |
| Concrete Walls | 2,750,000 |
| Vehicular Gates | 460,000 |
| Railroad Gate | 260,000 |
| Pumping Stations | 2,700,000 |
| Gated Conduits | 970,000 |
| Interior Drainage | 2,330,000 |
| River Overflow Channels | 2,430,000 |
| Utility Relocations | 1,900,000 |
| Detours during Construction | 230,000 |
| Ancillary Works | 450,000 |
| Downstream Mitigation | 1,000,000 |
| Archaeological Mitigation | 800,000 |
| TOTAL CONSTRUCTION COST | $29,280,000* |
| Engineering & Design | 2,640,000 |
| Supervision & Administration | 2,340,000 |
| TOTAL ESTIMATED FIRST COST | $34,260,000 |
| ROUNDED TO | $34,300,000 |
| **NON-FEDERAL-COST** | |
| Lands and Damages | $ 3,600,000* |
| Utility Relocations | 1,200,000 |
| TOTAL ESTIMATED NON-FEDERAL FIRST COST | $ 4,800,000 |
| TOTAL ESTIMATED PROJECT FIRST COST | $39,100,000 |

*Includes a 20% contingency factor

TABLE 7

SUMMARY OF INVESTMENTS

| | |
|---|---|
| Federal First Cost | $34,000,000 |
| Interest During Construction: | |
| ($34,300,000)(0.06875)(1/2x3) | 3,500,000 |
| TOTAL FEDERAL INVESTMENT | $37,800,000 |
| Non-Federal First Cost | $ 4,800,000 |
| Interest During Construction: | |
| ($4,800,000)(0.06875)(1/2x3) | 495,000 |
| | $ 5,295,000 |
| Rounded to | 5,300,000 |
| TOTAL NON-FEDERAL INVESTMENT | $ 5,300,000 |
| TOTAL FEDERAL AND NON-FEDERAL INVESTMENT | $43,100,000 |

TABLE 8

SUMMARY OF ESTIMATED ANNUAL COSTS

| | |
|---|---|
| Federal | |
| Interest & Amortization (0.06883 x $37,800,000) | $ 2,600,000 |
| Non-Federal | |
| Interest & Amortization (0.06883 x $5,300,000) | $ 360,000 |
| Operation & Maintenance | 14,000 |
| Major Replacement (Estimated) | 6,000 |
| | $ 380,000 |
| TOTAL ANNUAL COST | $ 2,980,000 |

## *BENEFITS*

Table 9 summarizes annual benefits from the Westfield Local Protection Project, which consist primarily of the reduction in flood damages.

TABLE 9 SUMMARY OF BENEFITS

| | |
|---|---|
| Basic Flood Control | $3,449,900 |
| Location | 146,500 |
| Affluence | 111,300 |
| Total Annual Benefits | $3,707,700 |

## *JUSTIFICATION*

Economic justification of the project is determined by comparing estimated annual benefits with estimated average annual costs, including interest and amortization. The calculation for this project is as follows:

$$\frac{\text{Total Annual Benefits: } \$3,707,700}{\text{Total Annual Costs: } \$2,980,000} = 1.24$$

The benefit-cost ratio is greater than 1.0 and the project is therefore economically justified.

## MAXIMIZATION

During the plan formulation phase of the study it was determined that local protection was the preferred flood control solution that would meet the social, environmental and economic criteria. Of the several plans of local protection considered, the selected plan was the one which best met these criteria. The selection of the height of the protective works then became the remaining variable. The height of protection which results in the greatest excess of benefits over costs is the most efficient from an economic consideration.

This analysis indicated that the height of protection for the selected plan would be equivalent to that required for the Standard Project Flood.

# DIVISION OF PLAN RESPONSIBILITY

The responsibilities for carrying out the plan are apportioned between the Federal Government and non-Federal interests on the basis of Federal legislation and administrative policies. Present cost apportionment was established by Section 3 of the 1936 Flood Control Act, as amended, but proposed cost-sharing reforms by the President could change this cost apportionment. The implications of both cost-sharing methods are discussed in the following paragraphs. However, under existing Corps policy, projects are recommended for authorization under the President's proposed cost-sharing guidelines.

## FEDERAL RESPONSIBILITIES

Under existing regulations, the Federal Government would be responsible for all flood control construction costs of the Westfield Local Protection Project. The currently estimated Federal share of first costs of the selected plan is $34.3 million. The Federal Government will also design and construct the project except for specified items of local cooperation. After construction is completed, the project will be turned over to the city of Westfield for operation and maintenance.

## NON-FEDERAL RESPONSIBILITITY

The currently estimated non-Federal share of the total first costs of the selected plan under existing regulations is $4.8 million. Non-Federal interests would also be required to maintain and operate the project after completion at an estimated average annual cost of $20,000.

Specific requirements of local cooperation include:

1. Provide lands, easements and rights-of-way for the construction and subsequent maintenance of the project. This is currently estimated at $3.6 million.

2. Hold and save the United States free from damages due to construction, operation and maintenance of the works, except damages due to the fault or negligence of the United States or its contractors.

3. Maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of the Army. This is currently estimated at $20,000 annually.

4. Provide all alterations and replacements of existing utilities. This is currently estimated at $1.2 million.

5. Prescribe and enforce regulations to prevent encroachment on the improved or unimproved channels and ponding areas and manage all project-related functions to preserve capacities for local drainage as well as for project functions.

6. Comply with provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

7. Give assurances of local cooperation, as required by Massachusetts General Laws, prior to the start of any construction.

Although not a requirement of the selected plan, local interests should consider and adopt such nonstructural measures as necessary to protect life and property outside the protected area. The selected plan supports and encourages such nonstructural measures by the community wherever possible. It is particularly important that Westfield implement a flood forecasting and early warning system for the protection of its citizens, especially if the selected plan is not implemented.

## *PROPOSED CHANGES IN FEDERAL AND NON-FEDERAL COST APPORTIONMENT*

In his June 1978 water policy message to Congress, the President proposed that the present cost-sharing requirements for flood control projects be modified. The changes proposed by the Administration include provisions for a cash contribution from benefiting States of 5 percent of the project first cost and a cash or in-kind contribution of 20 percent from other non-Federal interests. Application of this policy to the Westfield project would require a cash contribution of $1,955,000 from the Commonwealth of Massachusetts and a cash or in-kind contribution of $7,820,000 ($3,020,000 cash and $4,800,000 in-kind) from the city of Westfield and/or other non-Federal interests. Table 10 compares the Federal and non-Federal costs of the selected plan under both existing and proposed policies.

TABLE [illegible]

COMPARISON OF FEDERAL AND NON-FEDERAL FIRST COSTS UNDER EXISTING AND PROPOSED WATER RESOURCE POLICIES

| | Existing | Proposed |
|---|---|---|
| Federal Share | $34,300,000 | $29,325,000 |
| Non-Federal Share | 4,800,000 | 9,775,000* |
| TOTAL | $39,100,000 | $39,100,000 |

*Includes the 5% ($1,995,000) and 20% ($7,820,000) non-Federal contributions.

# PLAN IMPLEMENTATION

Before this project can be constructed, the following actions must take place:

.Review of this report by the Board of Engineers for Rivers and Harbors and the Office of the Chief of Engineers.

.Review by the Governor of the Commonwealth of Massachusetts and other interested Commonwealth and Federal agencies.

.Compilation of all review comments of the report.

.Forwarding of the report of Chief of Engineers to the Secretary of the Army

.Fowarding by the Secretary of the Army of the final report to the Congress, subsequent to his seeking the comments of the Office of Management and Budget regarding the relationship of the project to the program of the President.

.Congressional authorization of the project, including the funding for the design and construction of the project.

.Upon authorization, the inclusion of funds in the budget of the Chief of Engineers for design and construction of the project.

.When the Congress appropriates the initial funds for the project, the request for submittal of formal assurances of local cooperation will be made of the non-Federal interests. No funds can be expended for construction of the project unless the assurances of local cooperation satisfactory to the Secretary of the Army have been received.

.Advanced engineering and design studies would be initiated, project formulation reviewed, and the plan reaffirmed or modified as required to meet the then current conditions.

.Preparation of plans and specifications along with the engineering estimate of construction would be completed.

.Prior to the invitation for the solicitation of bids the local assurances would be required.

.Bids are invited and a contract awarded.

.Local interests would become responsible for the project's operation and maintenance upon completion of construction and turnover of the project to them.

.The Corps of Engineers along with local interests will furnish technical guidance and periodic inspections for the life of the project. A schedule of the above steps cannot be accurately estimated because of the variables in the reviewing and funding processes and uncertainty of local support for the project. However, if authorized and after initial funding of the project, the complete design and construction of the project would be accomplished within a 7-year period if adequate funds are available.

# *VIEWS OF NON-FEDERAL INTERESTS*

The Commonwealth of Massachusetts, Division of Fisheries and Game, Connecticut Valley Wildlife District is concerned with:

- Leaving all vegetation inside the dikes and planting the outside banks of the dikes to grass and herbaceous cover.

- Seeing the backwater areas outside the dikes left open at the downstream end, to allow fluctuation of water levels and the passage of fish.

The Commonwealth of Massachusetts, Division of Fisheries and Game, Field Headquarters, Westboro, states: "You should be aware, however, of ground nesting birds in the area..."

The Commonwealth of Massachusetts, Water Resources Commission, Division of Water Pollution Control, states: "...this project indicates that it will significantly alter the hydraulic characteristics of the Westfield and Little Rivers."

The Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Department of Environmental Management, Division of Water Resources, would like a thorough review of the environmental impacts of the project's structural measures, provisions for some kind of a linear parkway system, and a complementary nonstructural plan.

The Commonwealth of Massachusetts, Executive Office of Environmental Affairs, is concerned with:

- The impacts of the project on downstream communities.
- The necessity for protecting the land within the bend of the Little River, and
- Preventing further development on the remaining flood plain.

The Commonwealth of Massachusetts, Executive Office of Transportation and Construction, Department of Public Works, District 2 states: "We would not anticipate any significant environmental impact on our roadways as a result of your proposed work."

The Office of the Board of Selectmen, West Springfield, Massachusetts, notes that construction of the project will cause problems to their area and asks that the problems be addressed in the Environmental Impact Statement.

The Westfield River Watershed Association, Inc., is concerned with the project impact on the upstream and downstream communities. Further, it requests coordination with them at time of preparation of final plans and specifications.

City of Westfield Planning Board and Department suggests the use of the protective works as a linear park-bikeway system and comments on the preconstruction and post-construction project's environmental impacts.

# *REVIEW BY OTHER FEDERAL AGENCIES*

United States Environmental Protection Agency's Region 1 was concerned with:

.Bank erosion and scouring

.Project operation and maintenance

.Increased downstream flood profile

.Characteristics of proposed ponding areas

.Extensive detail on existing conditions, the proposed project and project impacts, and they suggested a study on structural and nonstructural (operating and maintenance) mitigating measures for some impacts.

The U.S. Department of the Interior, Fish and Wildlife Service commented on five facets of the proposed construction. These are:

.Dike and wall system

.Overflow systems and channel relocations

.General clearing and bank stabilization

.Interior drainage and

.Effects upstream and downstream.

Their extensive comments are concerned with type of slope protection, resultant velocity of water flow under some project conditions, provisions for fishways, preservation of the existing wetland and river channels, and hydraulic impact on upstream and downstream river channels and banks.

The Ecological Services Branch of the Fish and Wildlife Services states: "The Westfield River system is not anticipated to play a significant role in the Connecticut River Anadromous Fish Restoration Program because of the large number of existing and proposed dams and impoundments." U.S. Department of Agriculture, Soil Conservation Service commented on the project's possible significant environmental impacts.

The comments of Federal and non-Federal agencies are contained in Appendix 2.

# SUMMARY

The city of Westfield, located on the Westfield and Little Rivers in southwestern Massachusetts, has a long history of flooding. Between 1927 and 1955 no fewer than six major floods inundated the city's downtown area, causing significant residential, commercial and industrial property damage. The most recent of these disasters was the August 1955 flood of record. It caused $8 million in damages. Since then, additional development, improvements and the effects of inflation have created a situation in which a recurrence of a flood of that magnitude would leave an estimated $100 million of damage in its wake.

Although the flood problems in Westfield have been extensively studied for many years, there still exists no comprehensive protection for life and property within this 3,100-acre flood plain of homes and businesses. At the present time, the city has no system of flood forecasting and early warning to allow the timely evacuation of the area from floodwaters that descend from the hilly upstream basin within 8 hours or less of a flood-producing storm.

This study was undertaken in compliance with existing authority and recommendations of the Connecticut River Basin Plan -- of which the Westfield River Basin is a part -- to review existing reports, study watershed conditions, and recommend cost-efficient ways to reduce or eliminate flood damage in and around Westfield. The New England Division, Corps of Engineers had principal responsibility for conducting the study and preparing the report.

The watershed of the Westfield River is the fifth largest in the Connecticut River Basin. It covers 517 square miles of the eastern slopes of the Berkshire Hills in southwestern Massachusetts. The city of Westfield is a prosperous and growing community of 33,000 people with a diversified economy of industry, commerce and agriculture that is surrounded by a sparsely developed countryside offering numerous recreational opportunities. The city enjoys a mild climate, is accessible by major transportation modes, and has substantial amounts of vacant land for future development.

Since its earliest history, Westfield has utilized its extensive flood plain for settlement. Today, more than 3,100 acres

of developed and developable land lie in the flood plain of the Westfield and Little Rivers and Powdermill Brook, virtually the entire downtown area.

Flooding is the major water resource problem in the city of Westfield and the Westfield River watershed. Indeed, Westfield has been described as having one of the most serious flooding problems of any community in the entire four-state Connecticut River Basin. Although two flood control reservoirs -- Knightville and Littleville -- substantially reduce flood discharges in the basin, estimates of flood damage in Westfield in the event of a recurrence of the August 1955 flood of record are about $100 million. Other water resource problems in the basin are small by comparison.

A number of structural and nonstructural alternatives were considered in this study for the solution of Westfield's flood problems. While the establishment of a flood forecasting and early warning system for Westfield is considered to be one of the more important and urgent nonstructural measures, the study was unable to conclude that any single or combination of such measures would provide adequate protection for the developed Westfield flood plain.

Of the structural measures considered, upstream storage, channel improvements and diversion were all found to be impractical and/or ineffective. Local structural protection for the Westfield flood plain was the only measure found to provide adequate protection against the 100-year or Standard Project Flood.

Eight local protection plans were analyzed for their ability to provide adequate protection, meet the needs and objections of the local community, and display an acceptable benefit-cost ratio. Each of the plans is a variation of the basic system of walls and dikes, new channels, gates and pumping stations, and associated appurtenances proposed in previous studies. Each was measured against National Economic Development and Environmental Quality objectives.

The selected local protection project for Westfield consists of 8-1/2 miles of earth dikes and concrete walls organized into two "U" shaped loops. Three new channels would be excavated. Street gates, pumping stations, gated conduits and ponding areas would also be built. Construction would require about 3 years.

The plan would eliminate flood damage in the most highly developed 1,700 acres of downtown Westfield, an area which contains 2,200 residential properties, 400 commercial establishments and 40 public buildings. Most of the remaining 1,300 acres in the flood plain are agricultural or open land, with only about 30 residential

and commercial properties remaining subject to flooding. To minimize environmental impacts, the Westfield and Little Rivers would flow in their existing channels during times of normal flow and would be diverted through overflow channels during flood periods.

Significant impacts of the selected plan on the environment would be limited to increased flooding downstream from Westfield, requiring the raising of the dikes in West Springfield under any optimum plan, and impacts of transporting construction materials. Seven other potential impacts were identified as less than significant.

In addition to the primary flood protection benefits, Westfield could also use the project as the basis for a major recreation plan.

Total first costs of the selected plan are estimated at $39.1 million. Under existing law, the Federal share of the project would be $34.3 million and the non-Federal share $4.8 million. Under the President's proposed cost sharing reforms, the Federal share would drop to $29,325,000, while the non-Federal share would rise to $9,775,000. Annual maintenance costs are estimated at $20,000. Average annual benefits of the selected plan over its estimated 100-year life would be $3,707,700. With total annual costs of only $2,980,000, the project has a benefit-cost ratio of 1.24 and is therefore economically feasible.

# *STATEMENT OF FINDINGS*

The Division Engineer of New England Division, Corps of Engineers, has reviewed and evaluated, in light of the overall public interest, the information contained in the environmental statement, and other documents concerning the flooding of the city of Westfield, and the views of other agencies, organizations, and individuals on the environmental and other impacts of the selected plan for local flood control protection for the city of Westfield. In addition, the Division Engineer has inspected the project area and has participated in meetings with local government officials, representatives of other agencies and organizations, landowners and other concerned members of the public.

The possible consequences of constructing the selected local protection project, as well as each of the alternatives, were

studied and evaluated for environmental effects, social well-being, engineering considerations, and economic factors. Specific attention was given to alleviating flood damages, protecting cultural resources, and preserving natural aesthetics of the area.

Three alternative measures were studied: upstream storage, river diversion and local protection. The selected plan is one of eight local protection plans investigated; it would consist of two loops of earth dikes supplemented by concrete floodwalls where space is limited. The larger loop would protect the main portion of the city of Westfield between the Little and Westfield Rivers. The smaller loop would protect the northern portion of the city lying between the Westfield River and Powdermill Brook. New channels would be constructed where necessary to straighten channel alignments and to divert excess flows from natural channels retained within the dike system. Street gates and sandbag structures would be installed where the dike crosses streets or railroad lines. Interior drainage would be handled by two pumping stations, various conduits through the dike and six ponding areas for temporary storage of interior runoff. A pressure conduit would be required on Powdermill Brook where it enters the project area.

Engineering Considerations - The selected local protection plan would meet the flood protection needs of the area, satisfy the desires of local interests for improvement of the human environment and retention of aesthetic values and would provide the most economical solution consistent with sound engineering. The selected plan would provide a high degree of flood protection to the city of Westfield.

Environmental Considerations - Adverse environmental impacts resulting from construction of the selected plan would be less than for other local protection plans and would be minimized by preserving the existing river channels within the dike system. The major adverse impacts associated with the plan are the increased flood stages downstream of the project, which will increase flood damages in those areas, and the impacts associated with construction of the project.

Social Well Being - The selected plan would eliminate flood damages in about 1700 acres of the 3100 acres of the city of Westfield that would be inundated by the Standard Project Flood. For those within the protected area, the plan would eliminate the threat to life, health and safety caused by flooding. The interior drainage ponding areas and the roadways on top of the proposed dikes would provide recreational opportunities. Approximately 29 cultural

or archaeological sites have been identified which might be impacted by the selected plan. The impacts to these sites would be minimized prior to and during construction.

Economic Considerations - The selected plan would have a total first cost of $39,100,000 and an annual cost of $2,980,000. The plan has a benefit-cost ratio of 1.24 to 1, as determined using current Federal criteria for evaluation of water resources projects.

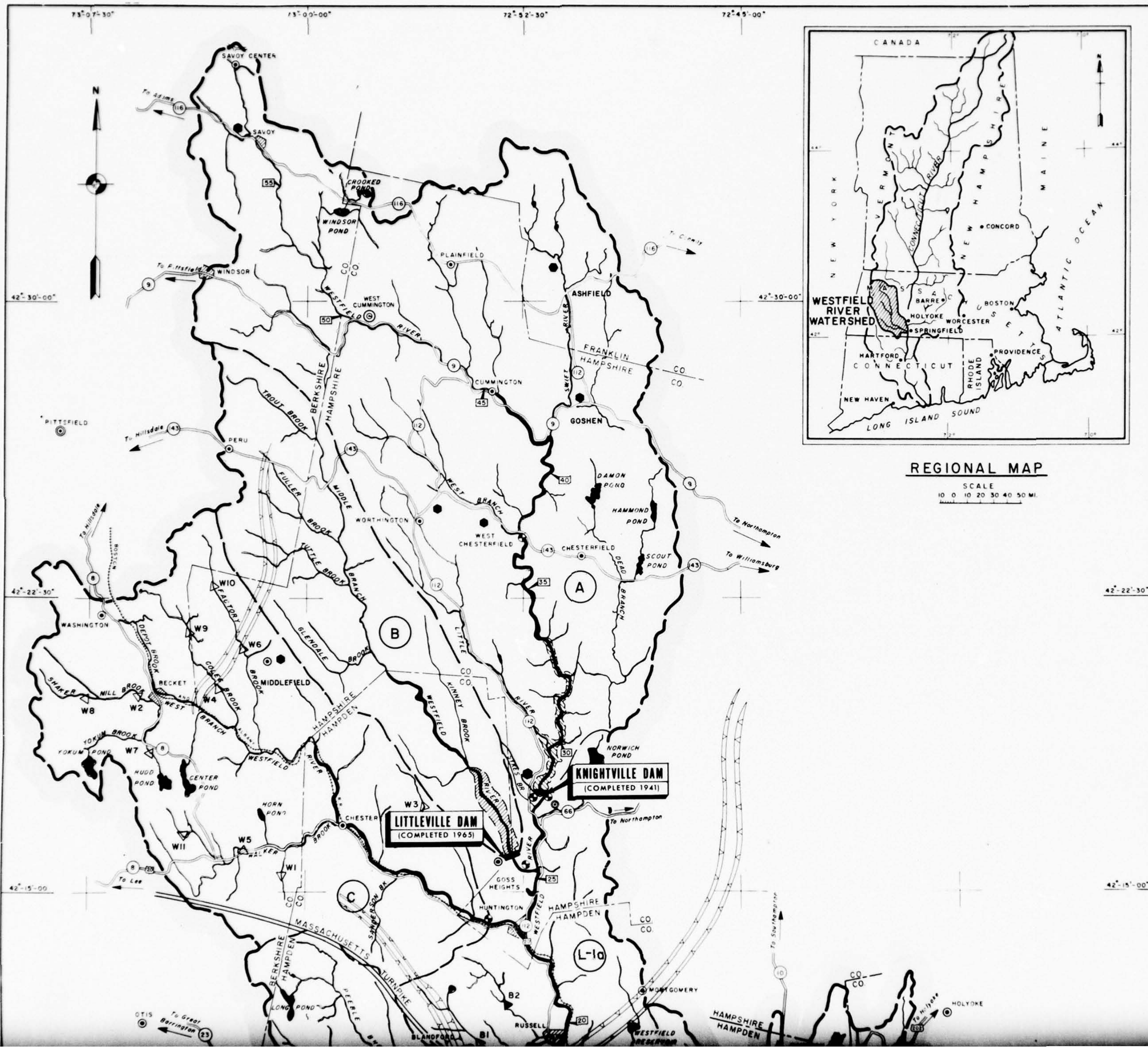
Other Public Interest Considerations - The flood protection for the city of Westfield is feasible and economically justified based on tangible benefits alone. Substantial intangible benefits, such as improved public health and reduced risk to human lives, would also accrue to the selected plan. However, the city of Westfield has not provided any adequate indication of support for the proposed plan.

The proposed improvements, as developed in the findings and recommendations of the report, are based on thorough analysis and evaluation of various practicable alternative courses of action for achieving the stated objectives; that wherever adverse effects are found to be involved they cannot be avoided by following reasonable alternative courses of action which would achieve the congressionally specified purposes; that where the proposed action has an adverse effect, this effect is either ameliorated or substantially outweighed by other considerations of national policy; that the recommended action is consonant with the national policy, statutues, and administrative directives; and that in the absence of adequate local support for the selected plan, the recommended plan for flood forecasting and emergency preparedness planning would best serve the public interest.

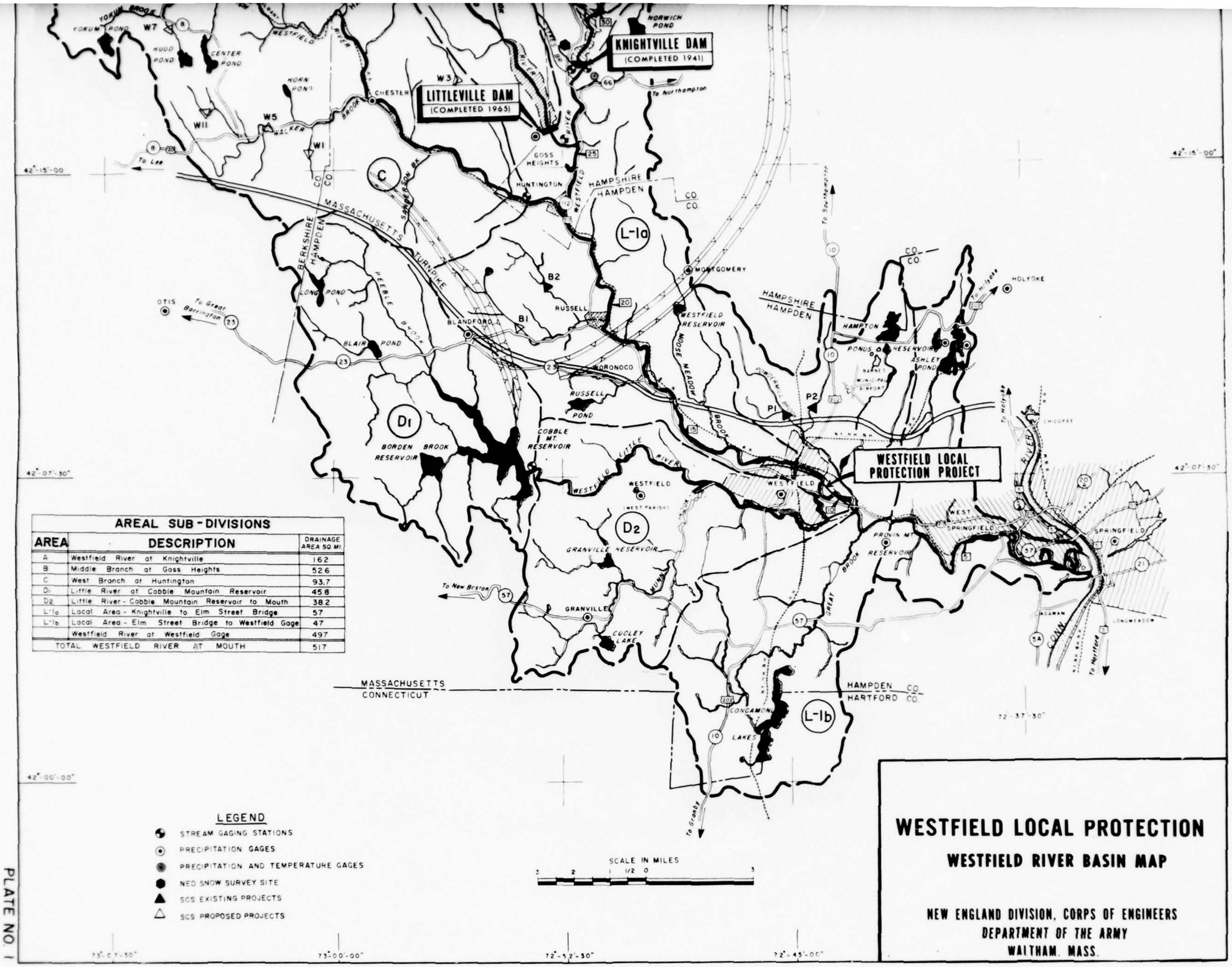
# RECOMMENDATIONS

In light of the present lack of any acceptable indication of local support, authorization of the selected local protection project for Westfield, Massachusetts is not recommended. However, because the city of Westfield remains vulnerable to serious flooding, it is strongly recommended that the city develop and implement an emergency preparedness plan to insure the health and safety of its citizens.

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer



REGIONAL MAP
SCALE
10 0 10 20 30 40 50 MI.
WESTFIELD RIVER WATERSHED
CANADA
NEW YORK
VERMONT
NEW HAMPSHIRE
MAINE
ATLANTIC OCEAN
CONNECTICUT RIVER
CONCORD
BOSTON
BARRE
HOLYOKE
WORCESTER
SPRINGFIELD
PROVIDENCE
HARTFORD
CONNECTICUT
RHODE ISLAND
NEW HAVEN
LONG ISLAND SOUND
KNIGHTVILLE DAM
(COMPLETED 1941)
LITTLEVILLE DAM
(COMPLETED 1965)
SAVOY CENTER
SAVOY
CROOKED POND
WINDSOR POND
WINDSOR
WEST CUMMINGTON
CUMMINGTON
PLAINFIELD
ASHFIELD
GOSHEN
FRANKLIN
HAMPSHIRE
BERKSHIRE
HAMPDEN
PITTSFIELD
PERU
WORTHINGTON
WEST CHESTERFIELD
CHESTERFIELD
DAMON POND
HAMMOND POND
SCOUT POND
NORWICH POND
WASHINGTON
BECKET
MIDDLEFIELD
CHESTER
HUNTINGTON
GOSS HEIGHTS
MONTGOMERY
RUSSELL
BLANDFORD
OTIS
HOLYOKE
WESTFIELD RIVER
SWIFT RIVER
WEST BRANCH
MIDDLE BRANCH
DEAD BRANCH
LITTLE RIVER
KINNEY BROOK
TROUT BROOK
FULLER BROOK
TUTTLE BROOK
GLENDALE BROOK
FACTORY BROOK
COLES BROOK
DEPOT BROOK
SHAKER MILL BROOK
YOKUM BROOK
YOKUM POND
HUDD POND
CENTER POND
HORN POND
WALKER BROOK
SANDERSON BK
LONG POND
PEEBLE
MASSACHUSETTS TURNPIKE
To Adams
To Pittsfield
To Hillsdale
To Lee
To Great Barrington
To Conway
To Northampton
To Williamsburg
To Southampton
To Holyoke
A
B
C
L-1a
W1
W2
W3
W4
W5
W6
W7
W8
W9
W10
W11
B1
B2
CO.
73°-07'-30"
73°-00'-00"
72°-52'-30"
72°-45'-00"
42°-30'-00"
42°-22'-30"
42°-15'-00"




# WESTFIELD LOCAL PROTECTION

## WESTFIELD RIVER BASIN MAP

NEW ENGLAND DIVISION, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY
WALTHAM, MASS.

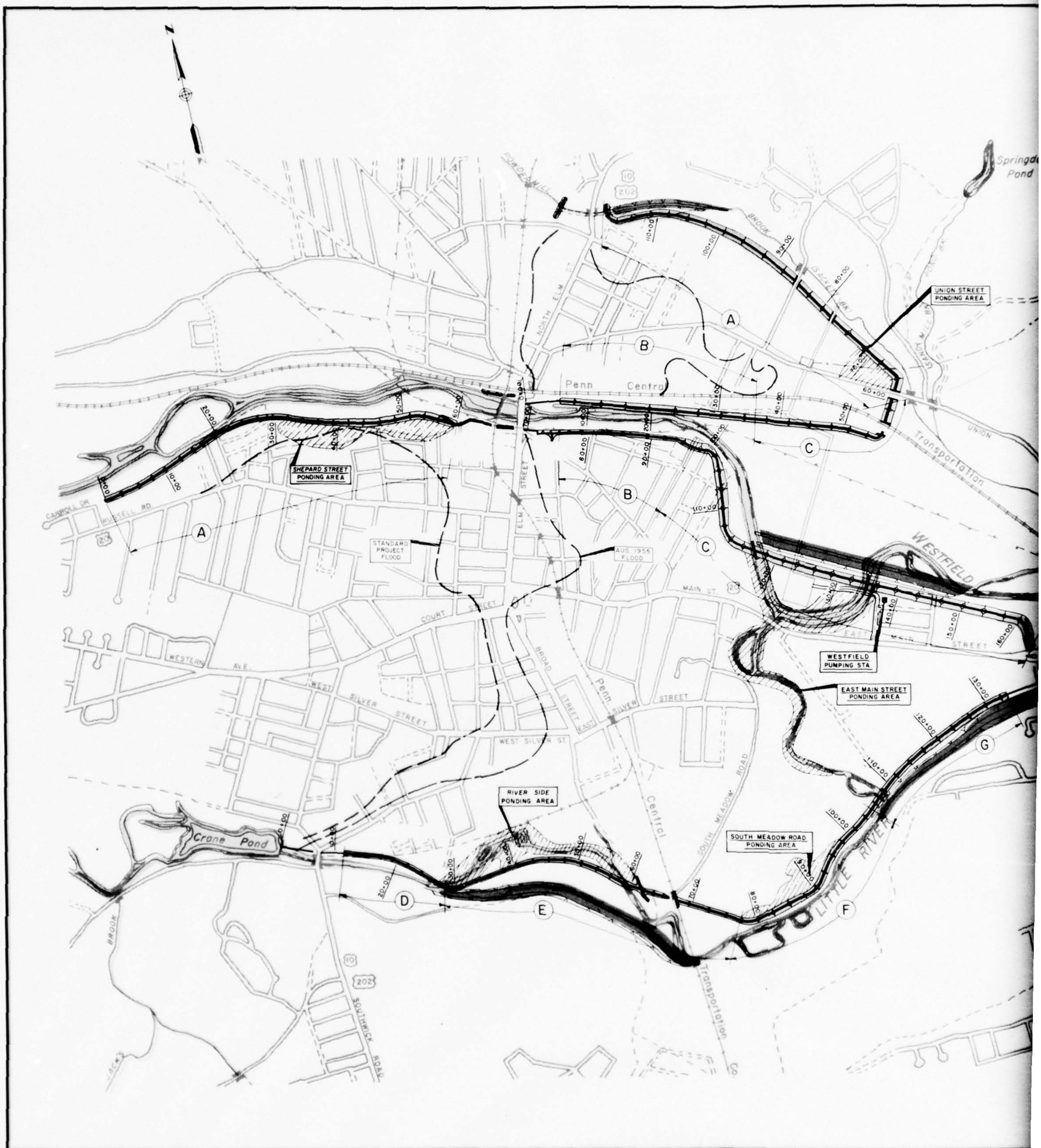
### AREAL SUB-DIVISIONS

| AREA | DESCRIPTION | DRAINAGE AREA SQ MI |
|---|---|---|
| A | Westfield River at Knightville | 162 |
| B | Middle Branch at Goss Heights | 52.6 |
| C | West Branch at Huntington | 93.7 |
| D1 | Little River at Cobble Mountain Reservoir | 45.8 |
| D2 | Little River - Cobble Mountain Reservoir to Mouth | 38.2 |
| L-1a | Local Area - Knightville to Elm Street Bridge | 57 |
| L-1b | Local Area - Elm Street Bridge to Westfield Gage | 47 |
| | Westfield River at Westfield Gage | 497 |
| TOTAL | WESTFIELD RIVER AT MOUTH | 517 |

LEGEND

- STREAM GAGING STATIONS
- PRECIPITATION GAGES
- PRECIPITATION AND TEMPERATURE GAGES
- NED SNOW SURVEY SITE
- SCS EXISTING PROJECTS
- SCS PROPOSED PROJECTS

PLATE NO. I



Springdale Pond
UNION STREET PONDING AREA
SHEPARD STREET PONDING AREA
STANDARD PROJECT FLOOD
AUG. 1955 FLOOD
WESTFIELD PUMPING STA.
EAST MAIN STREET PONDING AREA
RIVER SIDE PONDING AREA
SOUTH MEADOW ROAD PONDING AREA
Penn Central Transportation
WESTFIELD
LITTLE RIVER
Crane Pond
NORTH ELM ST.
ELM STREET
MAIN ST.
COURT STREET
WESTERN AVE.
WEST SILVER STREET
WEST SILVER ST.
BROAD STREET
EAST SILVER STREET
SOUTH MEADOW ROAD
SOUTHWICK ROAD
EAST MAIN STREET
CARROLL DR.
RUSSELL RD.
UNION
BROOK
A
B
C
D
E
F
G


WESTFIELD LOCAL PROTECTION

SELECTED PLAN

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE 2

**WESTFIELD RIVER**
CONNECTICUT RIVER BASIN

**LOCAL FLOOD PROTECTION**
WESTFIELD, MASS.

# APPENDICES

**WATER RESOURCES INVESTIGATION**

WESTFIELD LOCAL PROTECTION
WESTFIELD RIVER
WESTFIELD, MASSACHUSETTS

# TECHNICAL REPORT


SECTION A THE STUDY AND REPORT
B RESOURCES AND ECONOMY OF THE STUDY AREA
C PROBLEMS AND NEEDS
D HYDROLOGIC ANALYSIS
E FORMULATING A PLAN
F THE SELECTED PLAN
G ECONOMICS OF THE SELECTED PLAN
H DIVISION OF PLAN RESPONSIBILITIES
I NON-STRUCTURAL SOLUTIONS


WATER RESOURCES INVESTIGATION

## APPENDIX 1

# SECTION A

## THE STUDY AND REPORT

# THE STUDY AND REPORT

## SECTION A

## THE STUDY AND REPORT

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| PRIOR STUDIES AND REPORTS | A-4 |
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# SECTION A

# THE STUDY AND REPORT

This section presents background information concerning the authorization of this study. It also includes a description of the nature and extent of the study as an introduction to the contents and findings of this report.

## PURPOSE AND AUTHORITY

The purpose of this study is to investigate the flooding and associated water resource problems in the city of Westfield, Massachusetts, and to formulate a plan which would best solve these problems, consistent with the area's economic, social, and environmental well-being.

A local flood protection project for the city of Westfield was initially authorized by the Flood Control Act approved 14 July 1960 (Public Law 645, 86th Congress, 2nd Session). Detailed design was completed by the New England Division Corps of Engineers in 1963. However, the requirements of local cooperation were not met and the project was never constructed. The authorization for the project expired on 22 September 1969.

Other studies in the area were being accomplished under a resolution by the Committee on Public Works of the Unitd States Senate adopted 11 May 1962 which authorized a review of existing reports in the Connecticut River Basin. The resolution is as follows:

> "That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 12, 1902, be, and is hereby, requested to review the reports on the Connecticut River, Massachusetts, New Hampshire, Vermont, and Connecticut, published as House Document Numbered 455, Seventy-fifth Congress, second session, and other reports with a view to determining the advisability of modifying the existing project at the present time, with particular reference to developing a comprehensive plan of improvement for the basin in the interest of flood control, navigation, hydro-electric power development, water supply, and other purposes, coordinated with related land resources."

This resolution initiated a seven-year Federal-state study effort and resulted in a report entitled "Comprehensive Water and Related Land Resources, Connecticut River Basin, June 1970." The coordinating committee which guided the study then recommended a 1980 Connecticut River Basin Plan to meet the immediate water related needs of the basin. One element of the plan recommended that the original Westfield Local Protection Project be reauthorized and constructed essentially as previously authorized, except that the project be modified to include protection for the portion of the city of Westfield north of the Westfield River. This study was, therefore, conducted to determine the advisability of reauthorizing the local protection works for the city of Westfield.

## SCOPE OF THE STUDY

This report of survey scope comprises a study of the water resources problems of the city of Westfield, Massachusetts, for the purpose of determining the advisability of improvements in the interest of flood control and allied purposes. The study explores all reasonable alternative plans to solve the water resource problems. Several plans were studied in detail, including cost and benefit estimates. The most feasible plan was selected after considering all factors, including the views and desires expressed by Federal, state, and local officials, local civic groups, and concerned citizens. The plans were studied only in the depth and detail needed to permit plan selection and to determine its feasibility.

Information developed in prior and current relevant study programs was utilized to ensure a useful information base for the study. Other sources of existing data were utilized including local records, surveys, local investigations, and telephone calls to local officials for specific items of information. Significant data was developed from numerous field inspections and a four-month flood damage survey of the entire 3,100-acre flood plain. Soils tests and subsurface explorations performed for the 1963 General Design Memorandum were used and interpreted as necessary during this study. The 1963 Hydrology and Hydraulic Analysis Design Memorandum was reviewed and updated as necessary. All information included in this report is considered adequate for a feasibility scope study.

## *STUDY PARTICIPANTS AND COORDINATION*

The New England Division, U.S. Army Corps of Engineers, had the principal responsibility for conducting and coordinating the study, formulating the plan, consolidating information from other agencies, and preparing the report. Among the agencies and organizations involved during the study were the Soil Conservation Service, Environmental Protection Agency, Fish and Wildlife Service, New England River Basins Commission, the various resources agencies of the Commonwealth of Massachusetts and official and civic groups from the city of Westfield and surrounding communities. Coordination included informal meetings to discuss alternative plans considered, review of and comment on the draft of this report and the preliminary draft environmental statement for the selected plan, and participation at formal public meetings.

A public meeting was held on 18 March 1975 in the city of Westfield to allow for a broad based exchange of views and information between Corps personnel and interested local residents and other individuals and agencies. At this meeting, several alternative plans were presented. Comments, both informal and prepared, served as a helpful input to this report. Following the initial public meeting many smaller worksh p meetings were held with representatives of several local, state, and Federal agencies and other interested groups. The opinions and concerns raised during these meetings were incorporated into the study and aided in the formulation of the selected plan.

## *THE REPORT*

This report consists of a main report and three appendices. The main report is written in non-technical language and describes the area under study; its problems and needs with regard to flood and related water resources; formulation of the most suitable plan to meet these needs; benefits and justification; a summary of the project and recommendations for carrying out the proposed plan, including the responsibilities of Federal and non-Federal interests.

Appendix 1 is a technical report that follows the same general outline as the main report; however, it includes complete technical details on the conduct and findings of the study.

Appendix 2 contains all correspondence pertinent to the study.

Appendix 3 contains a report on the Cultural Resources Reconnaisance of the study area.

# PRIOR STUDIES AND REPORTS

The following studies and reports by the Corps of Engineers and other agencies are related to flood damage reduction in the area covered by this report:

a. Northeast Flood Studies - Interim Report on Review of Survey, Westfield River, Massachusetts, Corps of Engineers, November 1959.

This report was in response to the public concern arising after hurricane flooding in New England during August 1955. Its survey level scope comprised a review of flood problems in a number of watersheds including that of the Westfield River, for the purpose of determining the economic advisability of providing additional flood control improvements and making specific recommendations in the interest of flood control and allied purposes. It found that major flood damages occur along the Westfield River, particularly in the city of Westfield. In conclusion, it stated that additional flood control in the city, beyond that provided by the Knightville and Littleville Dams, is necessary and warranted. The report recommended that the authorized plan for flood control in the Connecticut River Basin be modified to provide for the construction of a local protection project along the Westfield and Little Rivers in Westfield, Massachusetts.

b. Powdermill Brook Watershed Protection and Flood Prevention Project.

This report was prepared by the Hampden Soil Conservation District and the city of Westfield with assistance by the U.S. Department of Agriculture Soil Conservation Service and Forest Service, and was completed in August 1961. The report covers the problems of flooding and associated damages along Powdermill Brook. Both structural and non-structural plans to alleviate the problems were proposed and later constructed. Structural measures include a flood water retarding structure on Powdermill Brook and a multiple purpose flood control and fish and wildlife enhancement pool on Arm Brook. The structures control the runoff from a 5,076 acre area, which represents 40 percent of the entire watershed and 79 percent of the area contributing to flood damages.

c. General Design Memorandum - Westfield Local Protection Project, Corps of Engineers, December 1963.

This General Design Memorandum covers the design of the project authorized by the 1960 Flood Control Act. It presents general data on structural components, complete site geology and costs and benefits of the proposed flood control project. The project was never constructed.

d. Hydrology and Hydraulic Analysis Design Memorandum - Westfield and Little Rivers, Massachusetts, Corps of Engineers, October 1963.

This report is part of the same Design Memorandum series as the General Design Memorandum described immediately above. Much of the data generated in this memorandum was used in formulating the general design for the proposed Westfield Local Protection Project.

e. *Flood Plain Information Report - Westfield, Massachusetts*, Corps of Engineers, June 1969.

This report assesses the problem of flooding along the Westfield and Little Rivers within the limits of the city of Westfield, Massachusetts. It was prepared by the Corps of Engineers at the request of the Massachusetts Water Resources Commission and is intended as a guide to regulate future development in the flood plain.

f. Work Plan for Watershed Protection and Flood Prevention; West Branch of the Westfield River Watershed, Berkshire, Hampden and Hampshire Counties, Massachusetts.

This report was prepared by the Massachusetts Department of Natural Resources and the Districts of the Soil Conservation Service for the contiguous counties along with assistance from other state and Federal agencies. The report was completed in July 1969.

The report deals with flooding and other water resources related problems in the basin of the West Branch of the Westfield River, which is located in the upper northwest reaches of the Westfield River watershed. The objectives of the study were to formulate plans and develop a comprehensive program of land management and structural measures to provide flood protection in the watershed while making maximum practical use of available water and land resources. The primary objective was to provide maximum flood protection with optimal economic and engineering efficiency. A plan was proposed to control the runoff from the 100-year frequency storm which made use of eleven structural components. Plans called for measures to reduce erosion and sediment production, retard flood runoffs and contribute to the recreational use of watershed land.

g. Comprehensive Water and Related Land Resources Investigation of the Connecticut River Basin.

This report was prepared by the interagency Connecticut River Basin Coordinating Committee, for which the New England Division, Corps of Engineers acted as the chair agency. The report was completed in June 1970. The early action plan proposed both non-structural and structural measures to provide for flood control and flood plain management. Structural type local flood protection projects at several locations were proposed to complement other flood control measures in the basin plan. Improvements proposed for the city of Westfield included 45,000 feet of earth dikes, 1,500 feet of conrete flood walls, two pumping stations, and 16,000 linear feet of channel improvements on the Little and Westfield Rivers and Powdermill Brook.

h. Present Status of Elements for Flood Damage Reduction - Holyoke, West Springfield and Westfield, Massachusetts; Connecticut River Supplemental Study.

This report was prepared by the center of the Environment of Man, Inc., for the New England Division, Corps of Engineers, February 1974. The report assesses the present status of flood damage reduction elements in those communities named in the title of the report, with specific reference to the town of Westfield. The report underscores the fact that a recurrence of a flood of magnitude of the Intermediate Regional flood (100 year frequency) would be disastrous to the economic and social well-being of the city of Westfield and the surrounding region. It concludes that additional study on the feasibility of providing local protection would be well advised, and that the need for some kind of action is unquestionable.

i. The River's Reach.

This report was prepared by the New England River Basins Commission and completed in December 1976. The purpose of this study of the Connecticut River basin in the states of Vermont, New Hampshire, Massachusetts, and Connecticut was to develop a long-term regional strategy of flood plain management within the river basin. The study supplemented the report Comprehensive Water and Related Land Resources Investigation of the Connecticut River Basin of June 1970. The main purpose of this supplemental study was to assist the communities within the basin to reduce flood damages. This was accomplished first by developing a regional strategy for reducing existing and future damage potential, and secondly by recommending both structural and non-structural courses of action for communities with the most significant problems.

j. Knightville Dam Modification, Corps of Engineers, June 1978.

This study of feasibility scope investigated the feasibility and desirability of modifying the existing Corps of Engineers' Knightville Dam and Reservoir project, which is situated on the Westfield River about fourteen miles upstream of the city of Westfield, to provide storage for additional flood control, a recreational pool, and low flow augmentation to enhance the downstream fishery resources. The existing dam and appurtenant structures were also reviewed to determine their stability under present design criteria, and the hydrologic and hydraulic inputs were recomputed based on present criteria and conditions. The report concluded that modifications to provide added flood control storage would not be economically justified. Added storage for recreation and low flow augmentation was not feasible for environmental reasons as well as a lack of public support from other Federal and non-Federal interests. The stability of the structures was essentially satisfactory, but minor structural modifications are required on the spillway due to updated design criteria.

## RELATED STUDY

West Springfield and Riverdale Local Protection Study

A study to determine the feasibility of modifying the existing flood control system to provide a higher level of protection was initiated by the Corps of Engineers in Fiscal Year 1977. The present height of the local protection system, which is located on the Connecticut and Westfield Rivers, was predicated upon a basin-wide system of reservoirs acting in conjunction with the localized system. However, the authorized level of tributary control in the Connecticut River Basin has not been realized and the existing projects do not provide the level of protection authorized by the Flood Control Act of 1938. The study is scheduled for completion in Fiscal Year 1980.

# SECTION B

## RESOURCES AND ECONOMY OF THE STUDY AREA

SECTION B

# RESOURCES AND ECONOMY OF THE STUDY AREA

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# SECTION B

# RESOURCES AND ECONOMY OF THE STUDY AREA

A general understanding of the resources and economy of the study area is useful in identifying the needs of the area and in assessing potential solutions. The purpose of this section is to describe the environmental, natural and human resources, and the development and economy of the Westfield River basin and the city of Westfield. Future trends of development are also discussed.

## ENVIRONMENTAL SETTING

The Westfield River basin, the fifth largest watershed in the Connecticut River basin, covers a large portion of the eastern slopes of the Berkshires in western Massachusetts. The majority of the watershed is located within Berkshire, Hampden and Hampshire Counties with small portions extending into Franklin County, Massachusetts and Hartford County, Connecticut. The watershed has an approximate length in a north-south direction of 48 miles, an average width of about 11 miles, and a drainage area of 517 square miles. The upper reaches of the watershed are generally hilly and mountainous with narrow, steep-sided valleys. Ridges in the headwaters rise 500 to 900 feet above adjacent valleys. The lower river valley is less rugged and the main stream widens and flattens as it leaves the uplands and flows eastward across the Connecticut Valley lowland to the Connecticut River.

### VEGETATION

The basin displays heavy vegetation, comprised of natural second and third growth forests. The damp, cool, mountainous western section is characterized by northern hardwood forests. The central portion of the basin has a variety of vegetation referred to as a transitional forest, where various types of forests are determined by local variations. The warmer eastern section of the basin consists mainly of the Oak-Chestnut climax community. Only sixteen percent of the land area is used for agriculture, and except for the southeast industrial centers, the basin is heavily wooded.

The landscape of the lower Westfield River basin is dominated by white pine-hemlock-hardwood forests, dotted with small farms. Within the city of Westfield, woodland is confined to riverbands, wetlands, steep hillsides, parks, and small privately owned tracts. Of these areas the steep hillsides and hilltops bordering the wide Westfield flood plain are the most extensively wooded. A major portion of the flood plain in the city is used for truck and tobacco farming, but in recent years many open fields have been converted to industrial and commercial building uses.

The Little River, between Southwick Road bridge and the Westfield River, is bordered by narrow bands of woodland, surrounded and interspersed by fields, croplands, and development. Much of this woodland is early successional growth of cottonwood, sumac, black cherry and black locust, with a dense understory of honeysuckle. More mature woods are found on the north-facing steep slopes of the river. This growth consists of sugar maple, white ash, butternut and red oak, with a more open understory of ironwood, black cherry, and scattered hardwood saplings.

Powdermill Brook, between the North Elm Street bridge and the East Main Street bridge, is primarily bordered by fields, croplands, and sand and gravel pits. Streamside vegetation is generally an early successional growth of ash maple, and elm saplings, mixed with herbaceous plants and woody shrubs. The only area of extensive woodland occurs near Sandy Hill Road; here the vegetation is primarily deciduous wooded swamp, dominated by red maple, with an understory of alder and silky dogwood.

The Westfield River, upstream of Shepard Street, has extensive flood plain woodland along its riverbanks. These woods consist of silver maple, sycamore, American linden, cottonwood, and green ash, with a sparse open understory and diverse groundcover. Downstream from Shepard Street, the woodland along the river is confined to occasional narrow bands, no more than two to three hundred feet wide. Depending on the slope orientation, degree of slope and soil moisture, these woods vary from moist woods, dominated by linden and green ash, to drier woods dominated by silver maple and cottonwood. The state dike is covered by tall grasses, primarily little bluestem, and numerous other herbaceous species. Other open areas contain primarily herbaceous growth.

FISH AND WILDLIFE

Three streams flow through the city of Westfield: the Little River, Westfield River, and Powdermill Brook. Of the three streams, Powdermill Brook has the best water quality, and for this reason has the best fish habitat.

The brook has been sampled by the Massachustts Division of Fisheries. In the upper section, only four species were found -- the creek chub, the blacknose dace, the common shiner, and the white sucker. These species, because of their abundance, are normally very important in the food chains of predacious fish. Since there were no higher order species found, it would appear that they may not serve this purpose in the upper stream. The brook is probably too shallow to support any major population of predators. In the lower section, more species were present. The same four as above; but in addition, pumpkinseed, fallfish, brooktrout, brown trout, and the American eel were present. The brook and brown trout are naturally reproducing. This is apparent since trout three inches long were collected: the Commonwealth usually does not stock trout less than six inches long. The numerous small springs entering the brook is the likely reason for the trout being present; they prefer cool waters. The brook is not ideal habitat since the bottom is almost entirely sand, but it is a source of recreational fishing.

The Little River has a poor fish habitat. The river's flow fluctuates substantially due to the retention and discharge of water from the dams on the river. In addition, the water quality is poor near Westfield. The fish found in the river include white suckers, darters, shiners, American eels, pumpkinseeds, bluegill and large-mouth bass. However, the fish present were very small, and the latter three sport species were not abundant. The river will remain a poor habitat for most fish until the quality of the waters improve and until the flows cease to fluctuate widely.

For the most part, the Westfield River is mainly a warm water fishery with the sunfish family being the primary game species, but again the water quality is poor. There is one section of the river, where Powdermill Brook joins the Westfield, that does have a fairly substantial trout population. This portion has been known to contain big trout weighing up to six or seven pounds. It is likely that the cool, high quality water from the brook is the major reason for this population. Although it is a very limited area, the local residents can have a sport fishery close to home.

The mammal and bird populations in Westfield would be typical of urbanized areas in New England.

The assemblage of mammals would primarily be field mice, skunks, foxes, shrews, raccoons and other such animals. The immediate area of Westfield would not contain any of the larger mammals such as bear or deer, but these animals would be found in the upper reaches of the basin.

As for the bird population, Westfield would contain a normal assemblage of warblers in wooded areas and swallows, hawks, and other such birds in open areas. None of these species are unusual for urbanized areas.

GEOLOGY

The Westfield River Basin lies mostly within the western highlands of Massachusetts, a rough, maturely dissected upland, underlain by crystalline rocks consisting of folded gneiss and schist with large masses of granitic rocks. The eastern part of the Westfield Basin is in the Connecticut Valley Lowland in which the bedrock is basalt ("trap rock") and sedimentary rocks consisting of sandstone, shale, and conglomerate. In the upland, which is generally blanketed by a thin veneer of till, bedrock outcrops in numerous and extensive areas. While the "trap rock" outcrops extensively in bold ridges in the lowland, outcrops of the sedimentary rocks are much less common. Overlying the till or bedrock in the lowland, and to a much lesser extent in the valleys in the upland, extensive deposits of stratified gravel, sand, silt, and clay occur as outwash plains and terraces. Deposits of the various types of materials used in construction occur scattered throughout the basin and are available in adequate quantities within reasonable proximity of any locality in the area.

STREAM CHARACTERISTICS

The Westfield River rises in the town of Savoy, Hampshire County, Massachusetts, at an elevation in excess of 2,000 feet above mean sea level. The river pursues a generally southeasterly course for about 57 miles, entering the Connecticut River between the towns of West Springfield and Agawam, Massachusetts, opposite the southern limits of the city of Springfield, about 75 miles above Long Island Sound. the Westfield River has a total fall of about 2,000 feet. The principal tributaries of the Westfield River are the Little River, the West Branch and the Middle Branch of the Westfield River. Numerous other smaller streams are also within the Westfield River system.

The Little River has its source in Cobble Mountain Reservoir in the southwest corner of the town of Russell and flows in the general easterly direction for about twelve miles to its confluence with the Westfield River in the city of Westfield. It has a drainage area of 84 square miles and a total fall of about 830 feet.

The West Branch of the Westfield River has its source in the northern section of the town of Becket and flows in a general southeast direction for about seventeen miles to its confluence with the Westfield River in the southwest corner of the town of Huntington. It has a drainage area of 96 square miles and a total fall of about 860 feet.

The Middle Branch of the Westfield River has its source at the Peru-Worthington town line in the northwest corner of Worthington and flows in a south-southeasterly direction for about sixteen miles to its confluence with the Westfield River at Goss Heights in the town of Huntington. It has a drainage area of 53 square miles and a total fall of about 1,140 feet.

## *CLIMATOLOGY*

The climate of the Westfield River Basin is generally moderate. In the southeastern portion of the basin, summers are not excessively hot and winters are generally mild, with hot spells in summer and cold periods in the winter usually being of short duration. Winters are longer and more severe in the northern and western parts of the basin, particularly in the higher elevations. The basin lies in the path of the "prevailing westerlies" which often include cyclonic disturbances that cross the country from the West or Southwest and converge on the Northeast United States and is subject to frequent but short periods of heavy precipitation. It is also exposed to occasional coastal storms that travel up the Atlantic Seaboard, some of them being of tropical origin and of hurricane intensity.

Mean annual temperature varies from about 44°F in the Berkshire Hills in the western part of the basin to about 50°F in the eastern part of the basin. Freezing temperatures occur from the latter part of October until late in April. The average January and February temperatures range from about 21°F in the western part of the basin to about 26°F in the eastern part of the basin, while the average July temperature ranges from about 68°F to 72°F.

The average annual precipitation over the Westfield River Basin is about 46 inches, uniformly distributed throughout the year. Maximum and minimum annual precipitation at Westfield during the 52 years of record through 1957 are 70.3 inches in 1955 and 33.7 inches in 1935. During August 1955, a total rainfall of 26.85 inches was recorded at Westfield. Average annual snowfall varies from 42 inches at Westfield (21 years of record) to approximately 60 inches in the Berkshires. At Westfield a maximum of 66.6 inches was recorded during the winter of 1945-46 and a minimum of 16.3 inches during the winter of 1936-37. The snow cover is generally at a maximum in February.

# NATURAL RESOURCES

The Westfield River Basin is limited in natural resources. The valley has a generally heavy cover of second and third growth woodland consisting chiefly of spruce, beech, yellow birch, and rock maple. Lumbering is not commerically extensive, although a few small sawmills operate in sections of the western highlands. Various mineral deposits are to be found in the valley, but few are of commercial value. Chester, whose principal industry is the manufacture of abrasives, has valuable deposits of corundum and emery in the area. The emery deposits have been worked intermittently since 1864, but are not currently being worked. Current mining and quarrying activities in the basin include a manganese mine at Plainfield; intermittent quarrying of granite at Becket; trap rock quarries at West Springfield, Westfield, and Southwick; and the production of clay, some marble, and small amounts of peat at Westfield.

WATER SUPPLY

More than 200,000 people draw their water from domestic water supply sources within the Westfield River Basin, the largest portion of this being surface water supply. Many industries also depend upon the basin to provide their manufacturing process water. The largest single source of water in the basin is Cobble Mountain Reservoir which supplies the city of Springfield and the towns of Agawam and Southwick, among others. Within the basin, eleven of the towns have public water supplies, the population of the remaining communities being so small that public supplies have not been developed. In general, the Westfield River and its tributaries provide sufficient water for public and industrial water supply needs in the basin.

HYDROELECTRIC GENERATION

The five hydroelectric plants in the Westfield River Basin have a total capacity of 38,710 kilowatts. The largest plant, operated by the Western Massachusetts Electric Company, is located at the Cobble Mountain Reservoir in the town of Russell and has an installed capacity of 33,000 kilowatts and a gross head of 456 feet. This is the only public utility hydroelectric plant in the basin. The other

four plants being industrial have installed capacities of 500 kilowatts or more. However, these industries do not rely entirely on water power at the present time, augmenting their power supply by means of steam generating plants or by purchase of public power during periods of low streamflow.

AGRICULTURE

In general, poor soil and rugged terrain combine to reduce the agricultural importance of the Westfield River Basin. Except in relatively small areas of rich, intensely cultivated land in the lower portion of the basin, the soil is much less fertile than in adjacent valleys, being rather droughty and sandy. In the upper portion of the basin, the valley is so rugged that its use for other than woodland is impractical. Little more than fifteen percent of the watershed is devoted to agriculture, and less than one-fifth of such land is used for crops. In addition, it has been reported that more than fifty percent of the pastureland is overgrazed, which further depresses the agricultural importance of the area.

The city of Westfield and town of West Springfield contain practically all of the intensively cultivated land in the basin, the principal crops being tobacco, truck, corn for silage, and hay. Next in importance are the towns of Southwick, Worthington, Blanford, and Cummington which devote considerable acreage to pasture and hay for dairy cattle. Other towns, although of little importance from a strictly agricultural standpoint, might be described as being engaged in a dairy type of farming. Many agricultural towns, such as Windsor, Peru, Chester, Chesterfield, Savoy, and Huntington, have failed to maintain a population growth since the middle of the 19th century.

RECREATION

Outdoor recreation within the watershed is diversified and extends throughout the four seasons. The five state forests and parks located wholly or partly within the basin provide opportunities for fishing, hunting, camping, swimming, boating, and picnicking. However, the scarcity of suitable water bodies limits recreational use of the basin. With the exception of the Congamond Lakes, most of the lakes and ponds suitable for recreational development are reserved for water supply purposes, and are not available for swimming and boating. Fishing in the basin is good, particularly in the forest ponds and streams, attracting sport fishermen from all parts of the state. Extensive stocking with pond fish and trout in ponds, brooks, and streams is carried on annually on both private and public lands. The Westfield River Basin is also a popular hunting area, with large numbers of well-wooded areas in the watershed providing excellent cover for game, and several hundred acres of forest reservation serving as wildlife refuges.

The two Corps of Engineers projects at Littleville and Knightville are operated to enhance public use. A 274-acre lake is maintained at Littleville for boating and fishing. The Massachusetts Division of Fisheries and Game operates an intensive trout stocking program in the areas of both Littleville and Knightville, and also stocks pheasants within the Knightville reservoir area. Other recreational activities include camping, picnicing, hiking, snowmobiling, and whitewater canoe races on the Westfield River during the spring releases of water from the Knightville project.

POPULATION CHARACTERISTICS

There are 28 Massachusetts cities and towns and two Connecticut towns lying wholly or partly within the Westfield River Basin. The estimated population of the basin (based on the 1970 Massachusetts State Census) is approximately 106,845, which is an increase of 22 percent over the 1960 Mass. State figure of approximately 83,528.

The population of the basin is about 76 percent urban and 24 percent rural, with all of the urban population being concentrated in the city of Westfield and the towns of Agawam and West Springfield. Less than one-half of one percent of the entire basin population is in the state of Connecticut.

The largest municipalities in the basin are the city of Westfield with a 1970 population of 31,433, of which all but about one percent is in the basin, and the town of West Springfield with a 1970 population of 28,461, of which about two-thirds are in the basin.

The watershed, particularly the area lying north of Westfield, is sparsely populated. Over three-forths of the communities with portions of their area lying within the watershed have population densities less than 100 persons per square mile. More concentrated populations are located in the communities lying totally or partly in the southeastern portion of the watershed, including the cities of Westfield, West Springfield and the town of Agawam. West Springfield has the highest population density of 1,699 persons per square mile and is followed by Agawam with 930 persons per square mile and Westfield with 670 persons per square mile.

Westfield, with a population of 32,863 in 1975, has shown an increase of 25 percent since 1960. Unlike similar sized communities in this part of the state, Westfield is maintaining a substantial growth pattern while the other communities are experiencing a loss of population. For the most part, its population has remained distributed in the center of the community radiating out from the central business district (CBD). A 1990 population projection reflects continued growth of 20.2 percent to 39,500. Table B-1 indicates Westfield's population trends.

TABLE B-1
Westfield's Population Trends 1900-1990

| Year | Population | % of Change |
|---|---|---|
| 1900 | 12,341 | |
| 1910 | 16,044 | 30.0 |
| 1920 | 18,604 | 16.0 |
| 1930 | 19,775 | 6.3 |
| 1940 | 18,793 | -5.0 |
| 1950 | 10,962 | 11.5 |
| 1960 | 26,302 | 25.5 |
| 1975 | 32,863 | 25.0 |
| 1990 | 39,500 | 20.2 |

Sources: U.S. Census
Lower Pioneer Valley Regional Planning Commission

In 1970, Westfield's population was overwhelmingly white and of native parentage. Census figures show 0.5 percent of the population was non-white. While 13.1 percent of the people in 1950 were foreign born, this figure dropped to 9.2 percent in 1960 and 6.3 percent in 1970. Of foreign stock, the dominant subgroups are Polish who compose 7.0 percent of the population and Canadian who compose 5.1 percent of the population.

A summary of Westfield's population characteristics, compared to those of the Springfield-Chicopee-Holyoke Standard Metropolitan Statistical Area (SMSA) and the state of Massachusetts are found in Table B-2.

TABLE B-2
Population Characteristics of Westfield, 1970
S-C-H SMSA, and Mass.

| Characteristics | Westfield | SMSA | State |
|---|---|---|---|
| Median age | 27.6 yrs. | 29.1 yrs. | 29.0 yrs. |
| Percent non-white | 0.5 | 4.6 | 3.6 |
| Percent foreign born | 6.3 | 7.5 | 8.7 |
| Percent foreign stock | 29.2 | 31.9 | 24.6 |
| Median number of school years completed | 12.2 | 12.1 | 12.2 |
| Median income | $10,614 | $10,369 | $10,835 |
| Percent families with incomes below $3,000 | 5.0 | 6.8 | 6.4 |
| Percent families with incomes above $15,000 | 21.1 | 20.8 | 25.1 |

## ECONOMIC DEVELOPMENT

The communities within the watershed were settled during the mid 1700's. The numerous rivers and streams on the eastern slopes of the Berkshires led to the erection of saw mills and grist mills throughout the entire area. Establishment of paper mills and tanneries also characterized early industry. Because the terrain in the southeastern portion of the watershed attracted this early industry, the communities in the northern portion of the watershed found it necessary to concentrate on agricultural activities. Such activities as dairying, poultry raising, and orchardry became important. Sheep raising, followed by the erection of woolen mills, became a main source of income for some communities.

These communities have maintained their rural character. Agricultural activities of the past are still carried on, as well as the processing of maple products and limited potato farming. Many of the inhabitants commute to jobs in the larger population centers in the Pittsfield and Springfield-Chicopee-Holyoke Standard Metropolitan Statistical Area (SMSA's).

With the availability of sources for water power, the lowland areas of Westfield, West Springfield and Holyoke, and the town of Agawam were more able to meet the needs of growing industries. During the 19th century, the manufacturing of whips and cigars became the principal occupations in Westfield. With the growth of firms producing such things as bicycles, textile machinery, wood products, precision tools, Westfield's interests turned from agriculture to industrial development.

Lying within the Springfield-Chicopee-Holyoke SMSA, Westfield is an important industrial and commercial center. Westfield draws many workers from other communities and many residents commute to jobs elsewhere. Westfield's economy has been characterized by continued growth over the past 25 years, with 5,765 local jobs in 1950 increasing to 11,961 by 1974. Employment more than doubled during this period while population grew by roughly fifty percent.

Westfield, with a long history as a manufacturing center, experienced an 84% increase in manufacturing employment between 1950 and 1974. Although its dominance has declined, manufacturing still provides more than one half of the private sector employment in the city.

Generally, between 1950 and 1974, there was consistent growth in all sectors with the exception of Mining and Construction, both of which had fluctuating levels of employment. Table B-3 shows the growth in total employment, the changing levels of employment in the different sectors, and the distribution of total employment in each sector.

TABLE B-3
Westfield Employment by Sector: 1950 - 1974

| | 1950 | 1960 | 1970 | 1974 | Percent Employment Distribution 1974 |
|---|---|---|---|---|---|
| Agriculture | 32 | 36 | 48 | 54 | 0.5 |
| Mining | 83 | 61 | 102 | 83 | 0.7 |
| Construction | 300 | 182 | 288 | 314 | 2.6 |
| Manufacturing | 3338 | 3488 | 5200 | 6140 | 51.3 |
| Trans., Comm., Util. | 78 | 111 | 159 | 222 | 1.9 |
| Wholesale/Retail | 1303 | 1625 | 2324 | 3102 | 25.9 |
| Fin., Ins., Real Est. | 157 | 179 | 222 | 349 | 2.9 |
| Services | 342 | 461 | 940 | 1697 | 14.1 |
| Total | 5765 | 6143 | 9282 | 11961 | 100.0 |

Source: Planning Report for Westfield, June 1976

LAND USE CHARACTERISTICS

Just less than one half of the total area of Westfield is developed. Of the developed area, more land is devoted to agricultural activities (37.2%) than any other activity. Residential, recreation, and transportation uses follow agriculture, each making up almost twenty percent of land utilization. Major land uses in Westfield are shown in Table B-4.

TABLE B-4
Major Land Uses in Westfield

| | Land Use (acres) | Percent of Developed Land | Percent of Total area |
|---|---|---|---|
| Residential | 2741 | 19.6 | 9.0 |
| Commercial | 208 | 1.5 | 0.7 |
| Industrial | 579 | 4.2 | 1.9 |
| Transportation | 2265 | 16.2 | 7.4 |
| Recreation | 2695 | 18.6 | 8.5 |
| Public Utilities | 229 | 1.6 | 0.8 |
| Public Buildings | 157 | 1.1 | 0.5 |
| Agriculture | 5190 | 37.2 | 17.7 |
| Total Land Developed | 13965 | 100.0 | 46.0 |
| Vacant Land | 15901 | | 52.3 |
| Water Bodies' | 538 | | 1.8 |
| Total area (land & water) | 30404 | | 100.0 |

Source: LPVRPC

It is clear that the city has utilized the flood plain for settlement and agriculture since early times. The denser urban development occurs in the flood plain west of the confluence of the Westfield and Little Rivers. This area was flat, easy to build upon, and accessible to roads and river travel. Approximately 3100 acres of heavily developed residential, commercial, industrial and agricultural areas of the city of Westfield are presently located in the flood plain at the junction of Westfield and Little Rivers and Powdermill Brook. The flood plain represents about one half the land of the present core city. About one fourth of that is currently open land.

The heart of the city is made up of industrial firms, shopping centers and businesses, public buildings, and homes. Well over 2200 residential properties, 400 commercial establishments, and 40 public buildings, comprise the major part of the main business district. Extensive development has also taken place on the flood plain east of the city center along State Route 20. The development of this area features two large shopping plazas, the Westgate Shopping Center and the Westfield Shopping Center, a bowling alley, a branch savings bank, a trailer park, and a vocational school. Industrial and commercial development has ocurred to the north of Route 20 in the same area and consists of several automobile dealerships, gas stations, and propane gas storage yard, a green house and New England Concrete Pipe, Inc. Approximately 500 multiple dwelling housing units have been build just to the south of Powdermill Brook.

## TRANSPORTATION

Westfield's transportation system provides for the movement of people and goods through the city, and connects the entire region. Air, bus, and rail freight facilities are also available. The public roads and highways are generally in good condition. The principal highways serving the city from east to west are U.S. Route 20 and Interstate 90 (Massachusetts Turnpike); and north to south U.S. Route 202, State Highway 10.

Barnes Municipal Airport, the third most active airport in Massachusetts, serves the greater Springfield area as well as much of the western part of the state. It covers a total of 1103 acres and is owned by the city. Airport traffic is dominated by operations from corporate and business jet aircraft.

Holyoke Street Railway Company, Peter Pan Buslines, Inc., and Springfield Street Railway Company, are franchised by the state to serve the city. Adequate bus service is provided between Springfield and Westfield Center. From Springfield, bus transportation to major East Coast cities is available. Freight service is provided by the Penn Central Railroad and several established trucking firms to long distance points.

Within Westfield, travel is principally by car. Although well linked to the region by major highways, the city suffers from internal congestion. Westfield's road pattern reflects the past, when the center of the city was the commercial and manufacturing focus. Although these activities have become dispersed, traffic generally is forced into the center to pick up another major artery.

## FUTURE DEVELOPMENT

Westfield's future, under the without project conditions, depends on the growth of population, the ability of the city to maintain economic integrity, and effectiveness of planning.

Westfield's accessibility to major transportation routes and signigicant amounts of vacant land, along with its relationship to the larger metropolitan area make it a favorable location for industrial growth. A recently conducted land use inventory concludes that the city has sufficient suitable land to accommodate future growth. The inventory indicated the necessity of conscious land use decisions so that desired growth will occur in appropriate land areas.

It seems almost inevitable that Westfield will grow. The community is very concerned about the type of development which will take place and would like to control this growth to meet the desired needs of the city. This is evidenced by the formation of a Planning Department in 1974.

Westfield's goals for future growth, development and change include: a balanced diversity of industrial, commercial and residential development, preservation of agricultural land and protection of flood plain. A goal is to concentrate development in the downtown area with improved circulation of the central business district, industrial development in the vicinity of the airport and improvement and enhancement of the image of the city.

# SECTION C

## PROBLEMS AND NEEDS

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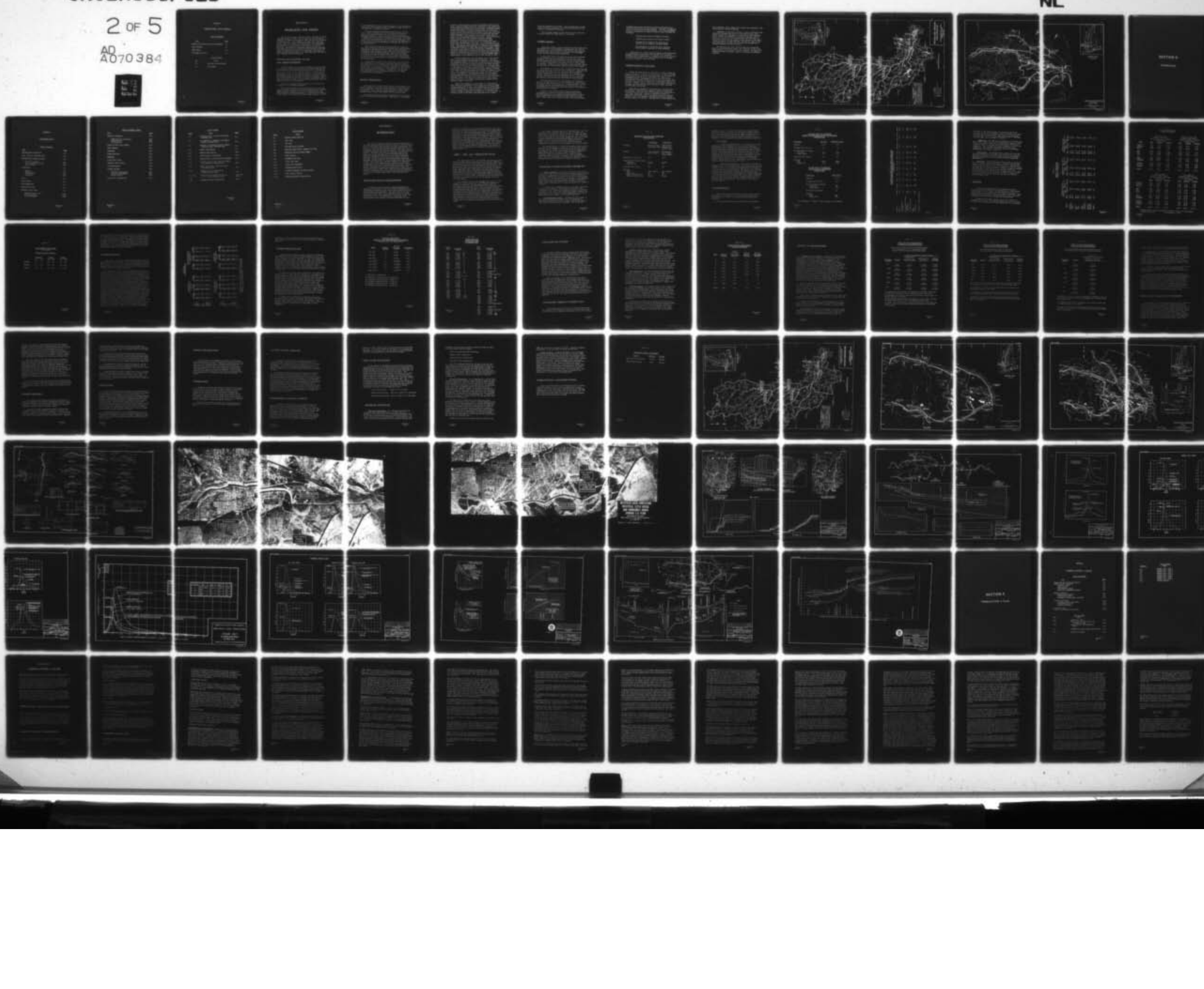

SECTION C

# PROBLEMS AND NEEDS

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| IMPROVEMENTS DESIRED | C-5 |


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| No. | Title |
|---|---|
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| C-2 | FLOOD AREAS |

# SECTION C

# PROBLEMS AND NEEDS

This section presents the water resource problems and needs addressed during the study. They include the major problem of flooding, the needs of conservation, fish and wildlife, recreation and water quality. Flood problems, including basin characteristics, historical floods, flood prone areas, and flood damages are discussed in a general way as they relate to the Westfield River Basin and specifically as they relate to the city of Westfield. More detailed information concerning basin hydrology and alternative plans for solving the flood problem will be presented in subsequent sections of this Appendix. The status of existing plans and improvements and those improvements desired by local interests are also discussed.

## STATUS OF EXISTING PLANS AND IMPROVEMENTS

Existing Federal water resource development projects within the watershed include Knightville Dam, Littleville Lake and the West Springfield Local Protection Project, built by the Corps of Engineers and three flood retarding structures built by the Soil Conservation Service of the U.S. Department of the Agriculture. In addition, in the city of Westfield there is a town maintained dike located along the right bank of the Westfield River. Several water supply reservoirs have also been built by municipal interests, the largest of which is Cobble Mountain Reservoir, built and operated by the city of Springfield.

The above improvements and the status of other plans are discussed in the following paragraphs.

The Corps' Knightville Dam and Littleville Lake are flood control reservoirs located in the upper Westfield River watershed. Knightville Dam, completed in 1941, is a single purpose flood control project, and Littleville Lake, in operation since 1965, is a multi-purpose flood control and water supply reservoir. As part

of the comprehensive plan for flood protection in the Connecticut River Basin, these projects reduce flooding at damage centers on the Westfield and Connecticut Rivers.

The West Springfield flood protection works are located along 2 miles of the West bank of the Connecticut River and 3 miles of the Westfield River. About 1,100 acres of highly developed industrial, commercial, public and residential property is protected by this system of dikes and flood walls. The project is operated and maintained by the town of West Springfield. The Corps is presently investigating the feasibility and desirability of raising the height of this system to increase the level of flood protection.

The three Soil Conservation Service projects, located on Black Brook, Powdermill Brook and Arm Brook, are located on small tributaries of the Westfield River. These structures reduce flooding in areas immediately downstream, but have a minor effect on flooding along the Westfield River. The Soil Conservation Service has also studied numerous potential sites for possible installation of flood retarding and multi-purpose impoundments, and have selected eleven sites in the upper part of the watershed for further study.

At Westfield, the dike on the right bank of the Westfield River upstream of the Elm Street bridge was constructed by the city prior to 1869. This dike has been overtopped or washed out several times. After the 1938 flood, it was rebuilt and extended downstream by the Commonwealth of Massachusetts. In 1955 this dike failed again by overtopping. Although the dike has since been repaired, it gives only limited protection to a highly developed section of Westfield.

## *FLOOD PROBLEMS*

The major water resource problem within the watershed is the periodic flooding of extensive areas of developed land within the city of Westfield. Since 1927, there have been six major floods in Westfield. These occurred during November 1927, March 1936, September 1938, December 1948, August 1955 and October 1955.

As shown on Plate C-1, the city of Westfield is at the lower end of the Westfield River Watershed. Since most of the upstream

terrain is steep and hilly, rainfall and snowmelt runoff is very rapid, creating frequent high water conditions in the valleys and in the broad, flat plains, such as the portion of Westfield which extends from Powdermill Brook southerly across the Westfield River to the Little River. Although the Knightville and Littleville projects provide substantial reductions in flood flows, this area remains susceptible to flooding from the uncontrolled watershed below these dams. These projects only control runoff from 43 percent of the watershed upstream of the city. During the record flood in August 1955, with Knightville Dam in operation (Knightville controls 33 percent of the watershed above Westfield), the Westfield flood plain was inundated by flood waters that reached depths of 20 feet. It is estimated that the total flood loss was about $8,000,000 in Westfield's main damage zones. Approximately 650 dwellings, 50 commercial establishments, 7 industrial firms and 16 farms experienced flood damage. After this flood, Littleville Lake was constructed (completed in 1965) to control runoff from an additional 10 percent of the watershed. However, a recurrence of the 1955 flood would again cause inundation in the city of Westfield but at a reduced maximum depth of approximately 18 feet instead of the 20 feet recorded in 1955.

Since the 1955 flood, the flood prone area in the city of Westfield has undergone considerable development. This area, which contains much of the residential, commercial, agricultural and industrial activity of the city, is characterized by extensive development in the central business district and along the main transportation routes. The remaining portion of the flood plain is predominantly residential or agricultural. Approximately 2200 residential properties, 400 commercial establishments, 40 industrial firms, 40 public buildings and 15 farms are situated in this area. Main transportation routes that cross this area are also subject to inundation. These include Routes 10 and 202 which provide north-south access, and Route 20 and the Penn Central Railroad which parallel the river on the valley floor and provide east-west access. The limits of flooding for the experienced August 1955 flood, the 100-year flood and the standard project flood are shown on Plate C-2.

Annual flood damages, for that portion of the Westfield River flood plain considered in this study, were based on damage surveys accomplished in 1974. This information was subsequently reviewed and updated to 1978 price levels. Without the proposed project, average annual existing damages, with Knightville and Littleville Dams in operation, are estimated to be $4,331,000. In addition, annual flood losses resulting from future economic

growth are estimated at $114,000. This is based upon an anticipated increase in affluence and is applied exclusively to the contents of residential structures.

Total average losses for that portion of the flood plain evaluated during this study amount to $4,445,000.

## OTHER NEEDS

Other water resource related problems and needs which may be associated with a flood management program within the city of Westfield are in the categories of water quality, municipal and industrial water supply, outdoor recreation, low flow augmentation, and fish and wildlife preservation.

Water supply within the watershed is more than sufficient for the needs of the city of Westfield and the rest of the watershed. Even with the diversions out of the watershed from Cobble Mountain Reservoir and Littleville Lake for water supply for the city of Springfield, the supply should be adequate for many decades. Local, pr vate or municipal users need only provide the facilities to obtain either surface or ground water supply.

The quality of the water within the Westfield River has been classified generally as Class B. The few sources of municipal and industrial pollution are in the process of being eliminated through improved treatment, and regulation of discharges into streams. The resulting quality throughout the basin and within the city of Westfield will be satisfactory for all industrial, agricultural, fish and wildlife, and outdoor recreation uses.

Low flow augmentation by the Littleville and Knightville projects has been considered, but the need was not sufficient at the time of study to justify the cost of implementation. It does not appear that low flow augmentation will be required in the foreseeable future because the remaining sources of pollution are being treated or eliminated.

As part of the Connecticut River Basin Comprehensive Investigation, the Bureau of Outdoor Recreation (Now called Heritage Conservation and Recreation Service) prepared a report that discussed recreation needs within the Connecticut River basin. Their study, which divided the basin into six sub-areas,

reviewed existing and anticipated recreation developments and projected future needs for each sub-area. Sub-area V included the portion of the basin within Massachusetts. The study recommended priority consideration of several recreation needs including the following:

- Improved water quality throughout the basin.
- Improved public access to the basin's waters.
- Programs should emphasize the planning and acquisition of streamside recreation areas.
- The development of additional water resources which would be responsive to urban pressures.

Construction of a local protection system in Westfield would set aside extensive riverside areas for public use as picnic, swimming or boat landing areas. In addition, the top of the earth dikes and other project lands would provide areas for walking, jogging, bicycling or other activities.

## *IMPROVEMENTS DESIRED*

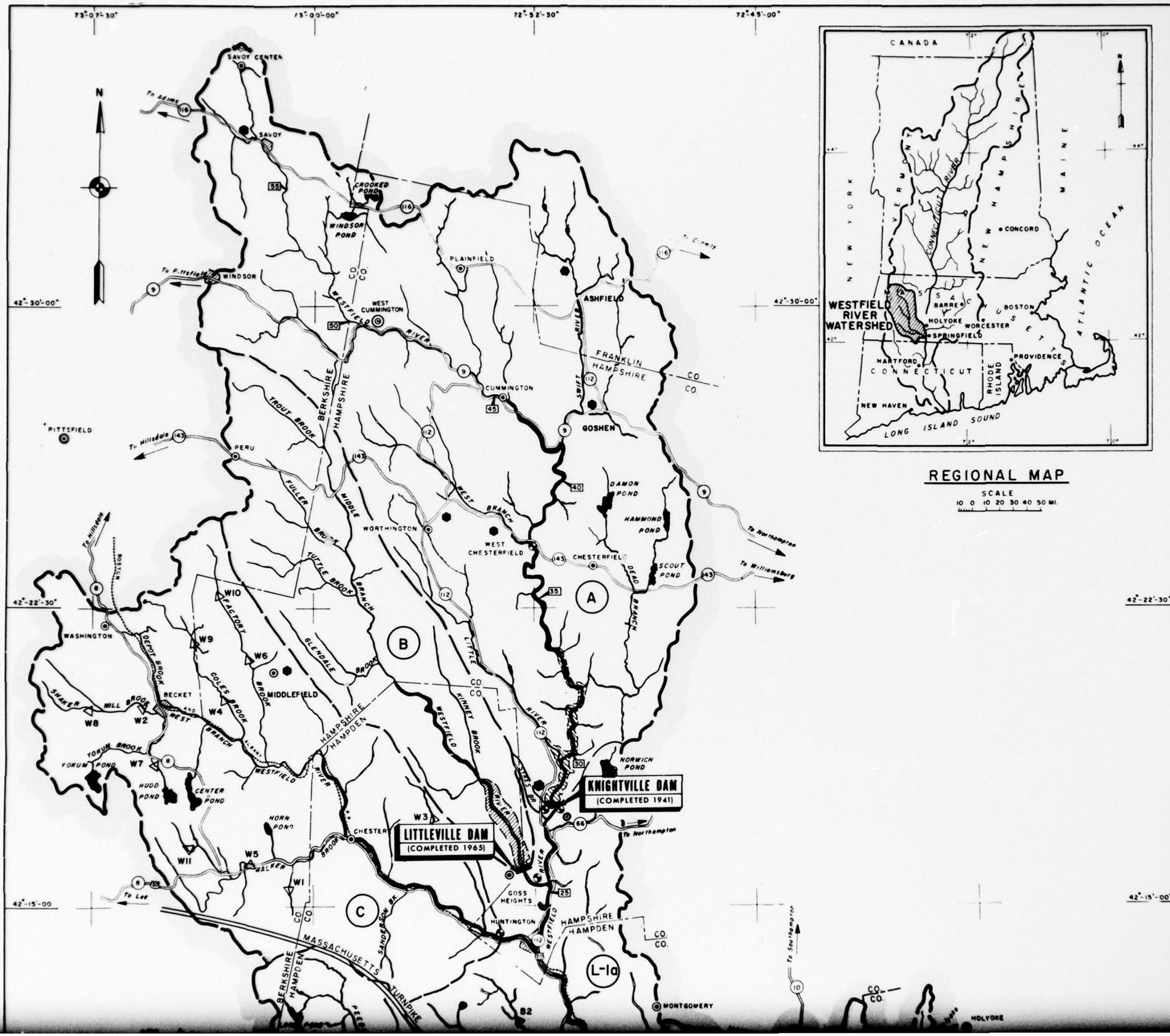
During the early stages of this study, a public meeting was held in the city of Westfield on 18 March 1975 to review the flood situation, describe various alternative methods of protecting the city against recurring floods, and obtain the views of all interested parties. Approximately 150 citizens participated in this meeting, including representatives of citizens' groups, local officials, and others with a personal or professional interest in the area. Numerous oral and written statements were presented and recorded, and many questions were answered by Corps' representatives during the meeting.

Those who participated in the meeting were concerned with the economic, social and other impacts of potential flood protection works. Many were also concerned about the possibility of their homes being taken in order to construct the dike or appurtenant structures. Other participants expressed a special interest in the environmental, cultural, historical and archaeological aspects of a project. Although most of these impacts had

been considered, these comments and concerns were discussed to the extent possible during the meeting.

Subsequent to the public meeting, a series of meetings, both formal and informal, were held with local authorities, civic leaders, groups and individuals. The purpose of these meetings was to solicit and incorporate the public's comments, and to arrive at a solution to the flood problems that would meet the objectives of the study and respond to the concerns of the public. During the course of these meetings, the public's input to the study continued to increase, and the Corps was provided with information needed for plan selection.

The selected plan, which resulted from this cooperative effort of the Corps and the public, is a variation of one of the plans presented at the March 1975 public meeting. The majority of changes were made to minimize impacts to existing environmental resources.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FULLER BROOK
MIDDLE BRANCH
WORTHINGTON
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HAMMOND POND
CHESTERFIELD
SCOUT POND
DEAD BRANCH
To Northampton
To Williamsburg
A
B
C
L-1a
TUTTLE BROOK
GLENDALE BROOK
LITTLE RIVER
KINNEY BROOK
WESTFIELD
W10
FACTORY
W9
W6
MIDDLEFIELD
WASHINGTON
DEPOT BROOK
BECKET
COLES BROOK
SHAKER MILL BROOK
W8
W2
W4
WEST BRANCH
ALBANY
HAMPDEN
YOKUM BROOK
YOKUM POND
W7
HUDD POND
CENTER POND
HORN POND
CHESTER
W3
W5
W11
W1
WALKER BROOK
To Lee
SANDERSON BK
MASSACHUSETTS TURNPIKE
NORWICH POND
KNIGHTVILLE DAM
(COMPLETED 1941)
LITTLEVILLE DAM
(COMPLETED 1965)
To Northampton
GOSS HEIGHTS
HUNTINGTON
To Southampton
MONTGOMERY
HOLYOKE
B2
PEEBLES
CANADA
NEW YORK
VERMONT
NEW HAMPSHIRE
MAINE
CONCORD
CONNECTICUT RIVER
ATLANTIC OCEAN
WESTFIELD RIVER WATERSHED
MASSACHUSETTS
BARRE
BOSTON
HOLYOKE
WORCESTER
SPRINGFIELD
HARTFORD
CONNECTICUT
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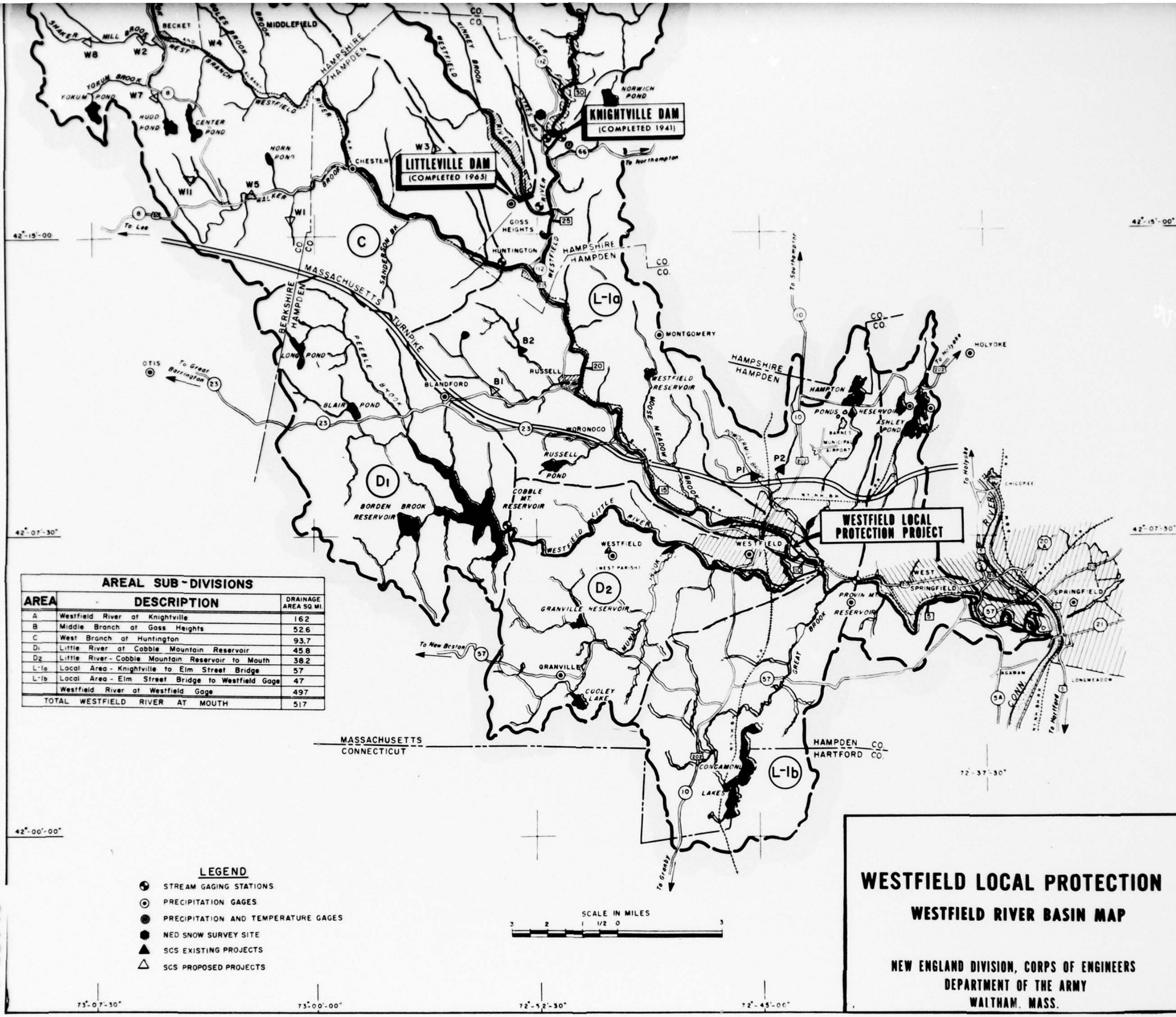



## AREAL SUB-DIVISIONS

| AREA | DESCRIPTION | DRAINAGE AREA SQ. MI. |
|---|---|---|
| A | Westfield River at Knightville | 162 |
| B | Middle Branch at Goss Heights | 52.6 |
| C | West Branch at Huntington | 93.7 |
| D1 | Little River at Cobble Mountain Reservoir | 45.8 |
| D2 | Little River - Cobble Mountain Reservoir to Mouth | 38.2 |
| L-1a | Local Area - Knightville to Elm Street Bridge | 57 |
| L-1b | Local Area - Elm Street Bridge to Westfield Gage | 47 |
| | Westfield River at Westfield Gage | 497 |
| TOTAL | WESTFIELD RIVER AT MOUTH | | 517 |

# WESTFIELD LOCAL PROTECTION

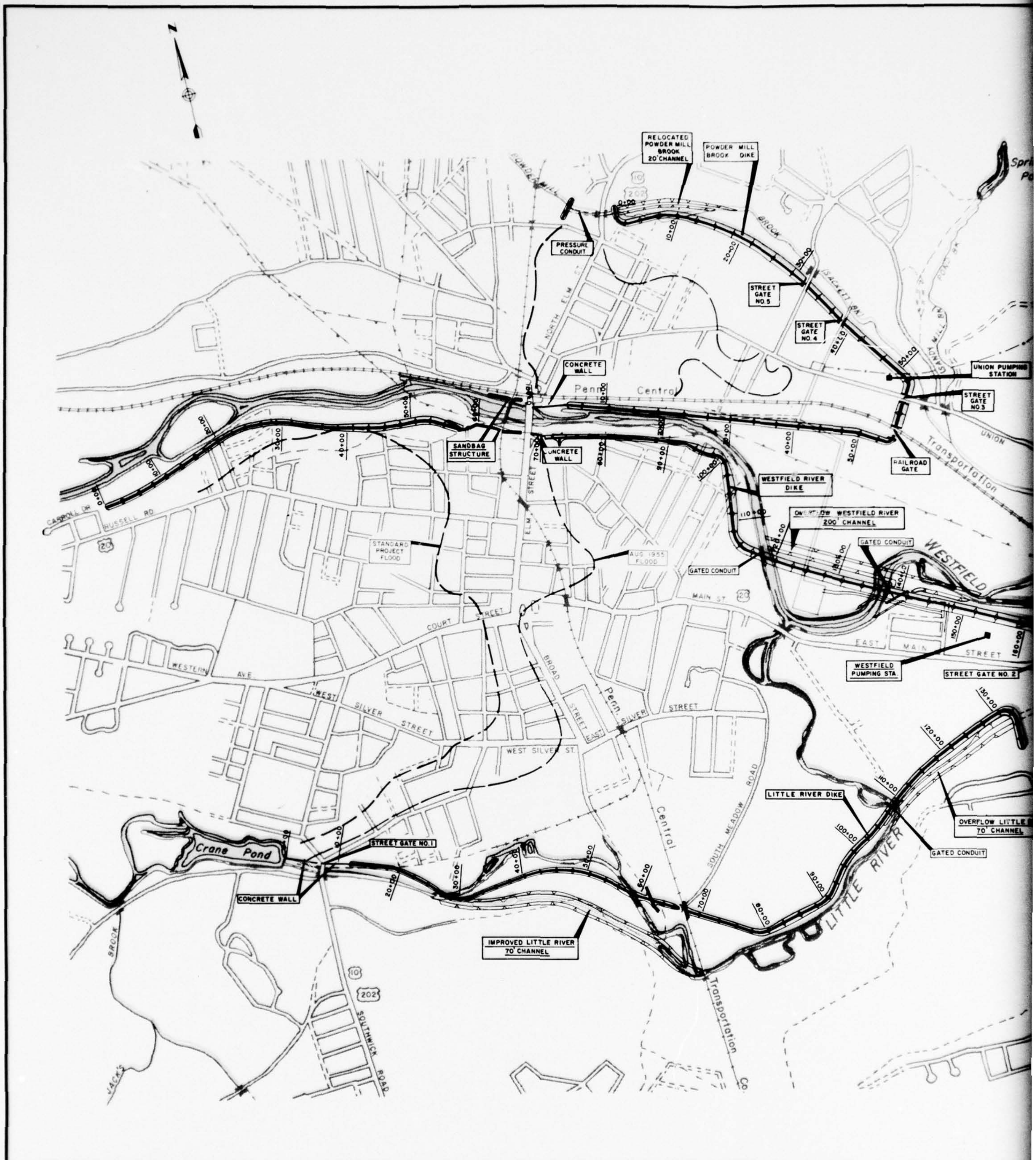
## WESTFIELD RIVER BASIN MAP

NEW ENGLAND DIVISION, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY
WALTHAM, MASS.

2

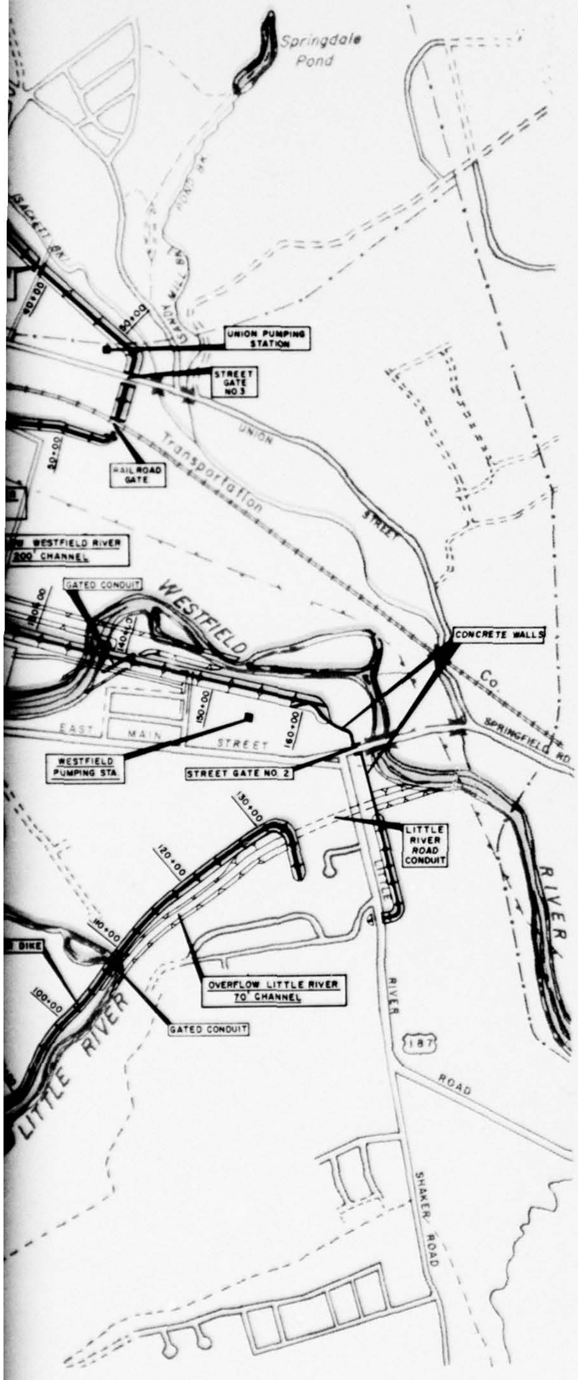
PLATE C-1

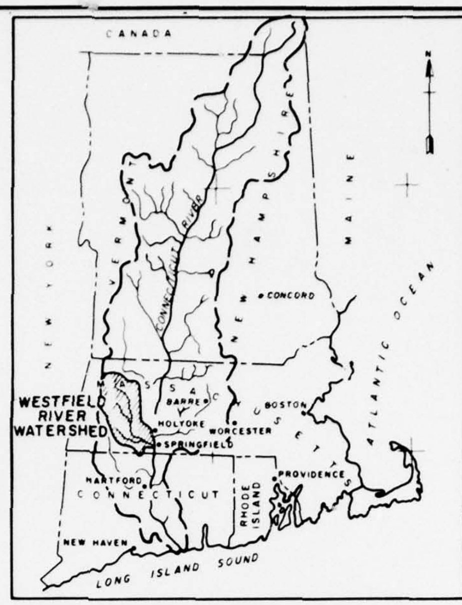
1



N
RELOCATED POWDER MILL BROOK 20' CHANNEL
POWDER MILL BROOK DIKE
PRESSURE CONDUIT
STREET GATE NO. 5
STREET GATE NO. 4
UNION PUMPING STATION
STREET GATE NO. 3
CONCRETE WALL
Penn Central
SANDBAG STRUCTURE
CONCRETE WALL
RAILROAD GATE
UNION
Transportation
WESTFIELD RIVER DIKE
OVERFLOW WESTFIELD RIVER 200' CHANNEL
GATED CONDUIT
GATED CONDUIT
WESTFIELD
STANDARD PROJECT FLOOD
AUG 1955 FLOOD
CARROLL DR
RUSSELL RD.
NORTH ELM ST.
ELM STREET
MAIN ST.
COURT STREET
EAST MAIN STREET
WESTFIELD PUMPING STA.
STREET GATE NO. 2
WESTERN AVE.
WEST SILVER STREET
BROAD STREET
EAST SILVER STREET
WEST SILVER ST.
Penn Central Transportation
SOUTH MEADOW ROAD
LITTLE RIVER DIKE
OVERFLOW LITTLE R
70' CHANNEL
GATED CONDUIT
LITTLE RIVER
Crane Pond
STREET GATE NO. 1
CONCRETE WALL
IMPROVED LITTLE RIVER 70' CHANNEL
SOUTHWICK ROAD
BROOK
JACKS

2




REGIONAL MAP

SCALE
10 0 10 20 30 40 50 MI.

**WESTFIELD LOCAL PROTECTION**
**FLOOD AREA**

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

**PLATE C-2**

# SECTION D

## HYDROLOGY

SECTION D

# HYDROLOGY

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# SECTION D

# HYDROLOGY

This section presents a hydrologic review and analysis of the flood situation at Westfield as it relates to three structural plans of improvement involving dikes and river relocations. The plans are: the originally authorized project (NED Plan, Plan 1), a modified version of that project, hereafter referred to as the Environmental Quality Plan (EQ Plan, Plan 7) and the Selected Plan (Plan 8). Included are sections on hydrologic description, analysis of floods, standard project flood development, and hydrologic engineering features of the projects as presently conceived. Extensive use was made of the results of earlier hydrologic studies including the Hydrology Design Memorandum completed in October 1963 for the local protection plan authorized in 1960. The studies were considered adequate for comparative costing and project planning studies, involving broad social, environmental, and economic decision-making processes. Pending a decision to proceed on a structural flood control plan, more extensive hydrologic engineering studies would be required during any detailed design stage. Also, flood plain zoning assurances should be considered as part of any further flood protection work to control the continued development of the Westfield flood plains.

## DRAINAGE BASIN DESCRIPTION

The Westfield River, located in Western Massachusetts, drains from the eastern slopes of the Berkshire Mountains in a southeasterly direction to its outlet to the Connecticut River in West Springfield, Massachusetts. The total area of the river basin is 517 square miles and at Westfield, which is located approximately eight miles upstream from the mouth of the river, the drainage area is 497 square miles. Elevations in the watershed vary from a high of 2,505 feet above mean sea level

(msl) at the headwaters in Savoy to about forty feet msl at the confluence with the Connecticut River. The basin is approximately fifty miles in length and twenty miles wide. The topography of the upper portion of the Westfield River basin, above the city of Westfield, is steep and rocky and drained by many small streams which produce rapid storm runoff. The slopes of the river and its tributaries in the upper mountainous regions are in the fifty feet per mile range, whereas, the slope of the river downstream of Westfield is considerably flatter, averaging about eight feet per mile. Principle tributaries to the Westfield River are the Middle and West Branches in the upper watershed, and the Little River which enters the Westfield River at Westfield. The location of these and other tributaries, plus respective drainage areas are shown on Plate D-1.

## *"NED", "EQ" and "SELECTED PLAN"*

The "NED Plan" or Plan 1 as described in Section E of this appendix would provide flood protection to the main commercial and residential portion of Westfield, lying generally west of East Main Street bridge between the Westfield and Little Rivers. This plan would consist of a dike along the left bank of the Little River from Stevens Paper Company dam, just upstream of Southwick Road bridge (Route 202), downstream to near East Main Street bridge (Route 20) and then continuing up the right bank of the Westfield River, tying into high ground approximately 7,000 feet upstream of Elm Street bridge. This project would have included relocation of a reach of both the Westfield and Little Rivers, and two street gate openings plus one 176 cfs pumping station for interior drainage.

The "EQ Plan" or Plan 7 as described in Section E of this appendix is a modified version of the "NED Plan" expanded to include protection for that developed northern portion of Westfield lying between the Westfield River and Powdermill Brook. This added protection consists of a dike extending from high ground down along the left bank of the Westfield River and then up the right bank of Powdermill Brook to high ground. Included in this line of protection would be four additional street gates, a railroad gate and a pumping station for interior drainage. With the "EQ Plan", a reach of the dike on the right bank of the Westfield River above Main Street bridge was moved inland to reduce the loss of flood plain storage and offset the loss of storage due to the added flood protection on the north side of the river.

Two further considerations in the "EQ Plan" were: (a) The placement of approximately 1,200 feet of the relocated Little River channel in a pressure conduit in order to reduce the impact on real estate takings and relocations, and (b) The installation of gated sluiceways to allow normal summertime river flow to pass through the Westfield and Little River dikes to maintain the aesthetic values of the existing river channels within the protected area. Each of the latter two modifications was incrementally analyzed for its environmental and economic impacts.

The "Selected Plan" or Plan 8 as described in Section E and Section F of this appendix is identical to the "EQ Plan" except that the concrete conduit at Little River Road is replaced by an open channel. Due to the small changes in project dimensions, design parameters such as water surface elevations, flow velocities, riprap slope protection and interior drainage facilities would be the same for both the "EQ" and "Selected Plan". An aerial photograph of Westfield with indicated limits of flooding and lines of protection are shown on Plate D-5.

## *EXISTING FLOOD CONTROL PROJECTS*

Corps of Engineers. The Corps of Engineers has two flood control reservoirs in the Westfield basin, namely, Knightville and Littleville. Knightville is located on the Westfield River at Huntington, Massachusetts and controls the runoff from the upper 162 square miles of the watershed. Littleville is a multipurpose water supply and flood control project, located on the Middle Branch in Huntington and Chester, with a drainage area of 52.3 square miles. Pertinent data on these two projects are listed in Table D-1.

A third Corps of Engineers project is the West Springfield Local Protection Project. This project is located at the confluence of the Connecticut and Westfield Rivers and provides protection to the city of West Springfield against flooding from both rivers. This project is located downstream of the city of Westfield and has no effect on flooding at Westfield.

Soil Conservation Service. Following the 1955 floods the Soil Conservation Service (SCS) of the U.S. Department of Agriculture constructed two small flood retention reservoirs in the tributary Powdermill Brook watershed. The SCS has also

TABLE D-1

## KNIGHTVILLE AND LITTLEVILLE RESERVOIRS
## PERTINENT DATA

| | Knightville | Littleville |
|---|---|---|
| Location | Westfield River Huntington, Mass. | Middle Branch Huntington & Chester, Mass. |
| Purpose | Single purpose - flood control | Multipurpose - water supply & flood control |
| Drainage Area (sq. mi.) | 162 | 52.3 |
| Flood Control Storage Capacity | | |
| Acre-Feet | 49,000 | 23,000 |
| Inches Runoff | 5.6 | 8.2 |
| Full Pool Area (acres) | 960 | 510 |
| Spillway | | |
| Type | Ogee overflow | Ogee overflow |
| Length (ft) | 400 | 400 |
| Design Surcharge (ft) | 15 | 15 |
| Design Discharge (cfs) | 85,000 | 92,000 |

proposed a system of retention reservoirs for the West Branch watershed, however, the future of this plan is somewhat indefinite. Pertinent data on the existing Powdermill Brook projects and for the Bradley Brook project are listed in Table D-2. Pertinent data on the proposed West Branch projects are listed in Table D-3. The locations of the projects are shown on Plate D-1.

<u>Other Projects</u>

Cobble Mountain Reservoir - This project is a single purpose water supply reservoir for the city of Springfield, Massachusetts and is located on the Little River, a tributary of the Westfield River at Westfield. The reservoir has a storage capacity of 67,500 acre-feet, equivalent to 27.6 inches of runoff from its contributing watershed of 45.8 square miles. If this project is less than full, at the time of a major storm, it can completely control the flood runoff from its watershed. Even if this project is initially full it produces a desynchronizing effect on flood runoff due to its large amount of surcharge storage. The project has a full pool surface area of 1,120 acres and an overflow spillway length of 135 feet.

Existing Westfield Dike - The history of flooding at Westfield dates back to colonial days. The first efforts by local residents to build a dike along the Westfield River occurred prior to 1869. This dike is located on the right bank of the Westfield River upstream of Elm Street bridge. The dike has been overtopped or washed out several times and after the 1938 flood it was rebuilt by the Commonwealth of Massachusetts, extended downstream of Elm Street and tied into high ground a short distance upstream from the mouth of the Little River. The dike failed in 1955 but has since been repaired and currently provides protection to a developed section of Westfield. The location of this dike is shown on Plate D-2.

## *CLIMATOLOGY*

The Westfield River basin has a variable climate typical of New England. The lower part of the basin near the Connecticut River valley has a milder climate than the mountainous upper watershed.

The watershed experiences both continental storms, which

TABLE D-2

## POWDERMILL BROOK SCS RESERVOIRS
## HAMPDEN AND HAMPSHIRE COUNTIES, MASSACHUSETTS
## PERTINENT DATA

| Reservoirs | Arm Brook | Powdermill Brook |
|---|---|---|
| Purpose* | S,F,R | S,F |
| Drainage Area (sq. mi.) | 3.4 | 4.6 |
| Net Flood Control Storage | | |
| Acre-feet | 581 | 966 |
| Inches Runoff | 3.3 | 4.0 |
| Full Pool Area (acres) | 56 | 56 |
| Spillway | | |
| Type | Earth | Earth |
| Length (ft) | 184 | 260 |

## BRADLEY BROOK SCS RESERVOIRS
## HAMPDEN COUNTY, MASSACHUSETTS
## PERTINENT DATA

| Reservoirs | Black Brook |
|---|---|
| Purpose* | S,F,W |
| Drainage Area (sq. mi.) | 2.8 |
| Net Flood Control Storage | |
| Acre-feet | 864 |
| Inches Runoff | 5.8 |
| Full Pool Area (acres) | 47 |
| Spillway | |
| Type | Veg. |
| Length (ft) | 300 |

* S - Sediment; F - Flood; W - Water Supply; R - Recreation

TABLE D-3

SCS PROPOSED RESERVOIRS FOR WEST BRANCH, WESTFIELD RIVER
BERKSHIRE, HAMPDEN AND HAMPSHIRE COUNTIES, MASSACHUSETTS
PERTINENT DATA

| Reservoirs | Blandford | Brooker | Cherry | Coles | Cushman | Factory | Rudd | Shaker | Upper Coles | Upper Factory | Walker |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Purpose* | S,F | S,F | S,F,R | S,F,R | S,F,R | S,F,R | S,F,R | S,F,R | S,F,R | S,F,R | S,F,R |
| Net Drainage Area (sq. mi.) | 0.8 | 2.4 | 2.4 | 1.4 | 1.0 | 4.0 | 2.3 | 3.6 | 2.9 | 3.9 | 8.7 |
| Net Flood Control Storage | | | | | | | | | | | |
| Acre-Feet | 246 | 643 | 631 | 417 | 315 | 1257 | 579 | 1139 | 1187 | 1107 | 2110 |
| Inches Runoff | 5.8 | 5.0 | 4.9 | 5.6 | 7.1 | 5.9 | 4.7 | 5.9 | 7.7 | 5.3 | 4.6 |
| Full Pool Area (acres) | 72 | 42 | 56 | 26 | 59 | 176 | 84 | 102 | 154 | 101 | 105 |
| Spillway | | | | | | | | | | | |
| Type | veg. | veg. | veg. | veg. | rock | rock | veg. | veg. | rock | veg. | veg. |
| Length (ft) | 175 | 100 | 100 | 100 | 30 | 50 | 175 | 400 | 30 | 300 | 400 |

*S-Sediment, F-Flood, R-Recreation.

move west to east over the area, and coastal storms moving northward up the eastern seaboard, some of tropical origin which may attain hurricane magnitude. Mass curves of rainfall and isohyetal maps for the hurricane associated storms of September 1938 and August 1955 are shown on Plate D-6.

Temperature. The mean annual temperature in the Westfield River basin varies from 44°F in the mountainous regions to about 50°F in the valleys. Temperature extremes have varied from a maximum of 104°F in the lower areas to a minimum of -29°F in the headwaters. Mean, maximum and minimum monthly and annual temperatures at Springfield, Knightville Dam and Stockbridge, Massachusetts are listed in Table D-4.

Precipitation. The average annual precipitation over the Westfield watershed is approximately 46 inches, quite uniformly distributed throughout the year. Table D-5 lists the average monthly precipitation at Peru, Knightville Dam and Westfield, Massachusetts.

Snow Cover. The Westfield watershed receives an average of about 70 inches of snowfall per winter. Snow surveys have been taken in the upper part of the basin since 1950. These surveys indicate that the water content of the snow cover normally reaches a maximum about the middle of March. Average, maximum and minimum water contents of the snow cover are listed in Table D-6. Floodflows produced by heavy rainfall in conjunction with snowmelt are a threat every year in the basin, however, the majority of peak floodflows in the past have been the result of intense rainfall runoff alone.

## *RUNOFF*

The U.S. Geological Survey has published streamflow records for varous locations in the Westfield River basin dating back to 1905. At the present time that agency maintains four gaging stations in the basin with one located at Westfield. These flow records, particularly those during flood periods, were used extensively in the hydrologic analysis of the watershed.

A summary of discharge records for the four stations is presented in Table D-7. The average annual runoff for the period of record for the Westfield River near Westfield, after adjustment

TABLE D-4

MONTHLY TEMPERATURES
(Degrees Fahrenheit)

| Month | Springfield, Mass. Elevation - 190 ft, msl (1904 - 1975) | | | Knightville Dam, Mass. Elevation - 630 ft, msl (1949 - 1976) | | | Stockbridge, Mass. Elevation - 820 ft, msl (1932 - 1975) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | Maximum | Minimum | Mean | Maximum | Minimum | Mean | Maximum | Minimum |
| January | 26.8 | 68 | -18 | 21.4 | 62 | -24 | 22.5 | 65 | -29 |
| February | 27.8 | 74 | -18 | 23.2 | 64 | -25 | 23.4 | 63 | -28 |
| March | 36.7 | 87 | -11 | 31.7 | 74 | -15 | 32.3 | 82 | -17 |
| April | 48.4 | 93 | 10 | 44.4 | 92 | 10 | 44.1 | 89 | 9 |
| May | 59.5 | 97 | 27 | 54.8 | 93 | 23 | 55.1 | 92 | 24 |
| June | 68.4 | 101 | 32 | 64.7 | 99 | 32 | 63.4 | 92 | 30 |
| July | 73.3 | 104 | 30 | 69.2 | 99 | 40 | 67.8 | 97 | 37 |
| August | 71.5 | 102 | 39 | 66.8 | 100 | 31 | 65.8 | 93 | 32 |
| September | 63.7 | 102 | 26 | 58.9 | 100 | 24 | 58.7 | 91 | 24 |
| October | 53.5 | 90 | 20 | 48.8 | 88 | 15 | 49.0 | 87 | 11 |
| November | 42.2 | 83 | 4 | 37.9 | 81 | 2 | 38.6 | 79 | -8 |
| December | 30.5 | 66 | -16 | 26.1 | 65 | -19 | 26.6 | 63 | -21 |
| ANNUAL | 50.2 | 104 | -18 | 45.6 | 100 | -25 | 45.6 | 97 | -29 |

TABLE D-5

MONTHLY PRECIPITATION
(Depth in Inches)

| Month | Westfield, Mass. Elevation 220 feet msl Period of Record - 71 Years (through 1976) Mean | Maximum | Minimum | Knightville Dam, Mass. Elevation 630 feet msl Period of Record - 28 Years (through 1976) Mean | Maximum | Minimum |
|---|---|---|---|---|---|---|
| January | 3.11 | 7.52 | 0.77 | 3.16 | 6.40 | 0.75 |
| February | 3.32 | 6.75 | 1.24 | 3.18 | 5.11 | 1.24 |
| March | 3.76 | 9.71 | 0.27 | 3.79 | 10.18 | 1.28 |
| April | 3.96 | 8.72 | 0.75 | 3.63 | 5.97 | 0.82 |
| May | 3.78 | 7.08 | 0.88 | 3.58 | 6.73 | 0.95 |
| June | 3.98 | 10.09 | 0.39 | 3.59 | 9.12 | 0.57 |
| July | 3.83 | 10.06 | 0.32 | 3.40 | 7.71 | 1.12 |
| August | 4.08 | 26.85 | 0.71 | 4.02 | 15.27 | 1.06 |
| September | 4.01 | 12.41 | 0.24 | 3.54 | 8.06 | 1.38 |
| October | 3.53 | 12.50 | 0.05 | 3.51 | 16.95 | 0.42 |
| November | 4.07 | 9.79 | 0.40 | 4.25 | 8.11 | 0.81 |
| December | 3.88 | 8.90 | 0.60 | 4.17 | 9.38 | 0.65 |
| ANNUAL | 45.31 | 70.33 | 29.69 | 43.82 | 62.36 | 32.15 |

| | Chester, Mass.* Elevation 600 feet msl Period of Record - 59 Years (through 1976) Mean | Maximum | Minimum | Peru, Mass.** Elevation 1860 feet msl Period of Record - 36 Years (Ends 1969) Mean | Maximum | Minimum |
|---|---|---|---|---|---|---|
| January | 3.50 | 6.83 | 0.57 | 3.73 | 7.31 | 1.00 |
| February | 3.34 | 5.77 | 1.26 | 3.28 | 6.58 | 0.93 |
| March | 3.92 | 10.49 | 0.21 | 4.16 | 10.32 | 1.25 |
| April | 3.85 | 8.37 | 0.75 | 3.76 | 6.43 | 0.68 |
| May | 4.37 | 9.92 | 0.79 | 4.03 | 7.77 | 0.92 |
| June | 4.46 | 14.31 | 0.23 | 4.33 | 10.55 | 1.53 |
| July | 4.22 | 10.16 | 1.01 | 4.60 | 10.88 | 1.73 |
| August | 4.44 | 18.44 | 0.54 | 3.76 | 14.07 | 0.78 |
| September | 4.07 | 12.61 | 0.40 | 4.66 | 12.36 | 0.68 |
| October | 3.75 | 17.51 | 0.00 | 3.65 | 14.37 | 0.76 |
| November | 4.63 | 11.01 | 1.00 | 4.27 | 8.35 | 1.13 |
| December | 4.13 | 11.39 | 0.76 | 3.93 | 10.37 | 1.14 |
| ANNUAL | 48.68 | 76.15 | 32.23 | 48.20 | 65.42 | 34.73 |

*Discontinued in 1957, new station located in vicinity of the original station since 1962.

**Discontinued in 1969

TABLE D-6

WATER CONTENT OF SNOW COVER
(in Inches)

Period of Record - 28 Years

| | February 1 | February 15 | March 1 | March 15 | April 1 | April 15 |
|---|---|---|---|---|---|---|
| Maximum | 5.2 | 7.3 | 8.0 | 9.5 | 9.3 | 3.6 |
| Minimum | 0.3 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| Average | 2.9 | 3.5 | 4.0 | 4.0 | 2.7 | 0.6 |

for water supply diversion, has varied from 44.1 inches in 1928 to 11.1 inches in 1965. The mean annual runoff for the period has been 25.7 inches (940 cfs) equivalent to approximately 56 percent of average annual precipitation. A summary of the adjusted mean, maximum and minimum monthly and annual runoff at the gage sites are shown in Table D-7. Although precipitation is quite uniform throughout the year, much of the winter precipitation is in the form of snow. As a result, approximately one-third of the runoff occurs during snowmelt in March and April.

## *FLOOD HISTORY*

The history of flooding at Westfield dates back to colonial days and there are historic accounts of fifteen damaging floods during the period 1776 to 1900. However, hydrologic data on these early floods is very meager or nonexistent. Hydrologic records commenced about the beginning of this century and since then there have been six major floods at Westfield.

The November 1927 flood resulted from heavy rains on 2-4 November, falling on ground saturated from excessive rains during the previous month. The flood of March 1936 was caused by four distinct storm centers which passed over the northeastern part of the United States between 9 March and 22 March. The runoff from these rains was augmented by considerable snowmelt. The September 1938 flood resulted from the heavy rainfall accompanying a tropical hurricane that passed over New England on 21 September. The flood on December 1948 resulted from heavy rains falling on frozen ground with some initial augmentation from snowmelt. The flood of August 1955, the maximum flood of record at Westfield, was caused by rainfall associated with hurricane Diane. This flood was exceptionally severe because the storm was centered over the lower basin resulting in maximum runoff from that portion of the watershed uncontrolled by Knightville Reservoir. The flood of October 1955 was caused by a slow moving storm which passed over New England with heavy amounts of precipitation in the Westfield basin. The greatest flows at Westfield since 1955 occurred in June 1972 and December 1973 when moderately intense rainfalls resulted in peak flows of just over 12,000 cfs at Westfield. Had it not been for Knightville and Littleville reservoirs it is estimated that the peak flow at Westfield in December 1973 would have been in the order of 27,800 cfs. A summary of floods at Westfield this century is shown in Table D-8. Rainfall maps of

TABLE D-7
MONTHLY RUNOFF
WESTFIELD RIVER WATERSHED

| Month | Westfield River at Knightville, Mass.(1) (D.A. = 162 square miles) 1909 - 1974 | | | | | | Middle Branch Westfield River at Goss Heights, Mass.(2) (D.A. = 52.6 square miles) 1910 - 1974 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average | | Maximum | | Minimum | | Average | | Maximum | | Minimum | |
| | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches |
| January | 279 | 2.0 | 1305 | 4.8 | 46 | 0.3 | 95 | 2.1 | 213 | 4.7 | 15 | 0.3 |
| February | 260 | 1.7 | 667 | 4.3 | 65 | 0.4 | 85 | 1.7 | 239 | 4.7 | 17 | 0.4 |
| March | 614 | 4.4 | 2050 | 14.6 | 158 | 1.1 | 208 | 4.6 | 653 | 14.3 | 60 | 1.3 |
| April | 923 | 6.4 | 1757 | 12.1 | 302 | 2.1 | 290 | 6.2 | 594 | 12.6 | 85 | 1.8 |
| May | 433 | 3.1 | 910 | 6.5 | 166 | 1.2 | 132 | 2.9 | 280 | 6.1 | 41 | 0.9 |
| June | 231 | 1.6 | 829 | 5.7 | 41 | 0.3 | 66 | 1.4 | 351 | 7.4 | 4 | 0.1 |
| July | 122 | 0.9 | 479 | 3.4 | 21 | 0.2 | 32 | 0.7 | 150 | 3.3 | 5 | 0.1 |
| August | 98 | 0.7 | 745 | 5.3 | 16 | 0.1 | 27 | 0.6 | 316 | 6.9 | 3 | 0.1 |
| September | 115 | 0.8 | 986 | 6.8 | 16 | 0.1 | 32 | 0.7 | 328 | 7.0 | 1 | 0.1 |
| October | 153 | 1.1 | 1394 | 10.8 | 18 | 0.1 | 51 | 1.1 | 507 | 11.1 | 4 | 0.1 |
| November | 288 | 2.0 | 1155 | 7.1 | 39 | 0.3 | 98 | 2.1 | 366 | 7.8 | 9 | 0.2 |
| December | 307 | 2.2 | 1033 | 7.4 | 69 | 0.5 | 108 | 2.4 | 351 | 7.7 | 18 | 0.4 |
| Water Year | 321 | 26.9 | 537 | 45.1 | 137 | 11.5 | 103 | 26.5 | 182 | 47.1 | 43 | 11.0 |

| Month | West Branch Westfield River *at Huntington*, Mass. (D.A. = 93.7 square miles) 1935 - 1974 | | | | | | Westfield River(3) at Westfield, Mass. (D.A. = 497 square miles) 1914 - 1974 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average | | Maximum | | Minimum | | Average | | Maximum | | Minimum | |
| | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches |
| January | 170 | 2.1 | 404 | 5.0 | 49 | 0.6 | 840 | 2.0 | 2211 | 5.2 | 196 | 0.5 |
| February | 169 | 1.9 | 371 | 4.2 | 44 | 0.5 | 812 | 1.8 | 1761 | 3.9 | 234 | 0.5 |
| March | 347 | 4.3 | 1089 | 13.5 | 121 | 1.5 | 1700 | 4.1 | 5515 | 12.9 | 618 | 1.5 |
| April | 508 | 6.1 | 1067 | 12.8 | 158 | 1.9 | 2405 | 5.5 | 4908 | 11.1 | 855 | 1.9 |
| May | 234 | 3.0 | 452 | 5.6 | 81 | 1.0 | 1233 | 2.9 | 2465 | 5.7 | 458 | 1.1 |
| June | 133 | 1.6 | 684 | 8.2 | 25 | 0.3 | 693 | 1.6 | 1926 | 4.4 | 181 | 0.4 |
| July | 65 | 0.8 | 307 | 3.8 | 8 | 0.1 | 432 | 1.0 | 1600 | 3.7 | 114 | 0.3 |
| August | 56 | 0.7 | 630 | 7.8 | 8 | 0.1 | 340 | 0.8 | 3393 | 7.9 | 83 | 0.2 |
| September | 58 | 0.7 | 575 | 6.9 | 9 | 0.1 | 380 | 0.9 | 2941 | 6.7 | 89 | 0.2 |
| October | 97 | 1.2 | 1033 | 12.8 | 16 | 0.2 | 439 | 1.1 | 4879 | 11.4 | 103 | 0.2 |
| November | 167 | 2.0 | 542 | 6.5 | 25 | 0.3 | 846 | 2.0 | 3384 | 7.7 | 202 | 0.5 |
| December | 202 | 2.5 | 662 | 8.2 | 40 | 0.5 | 934 | 2.2 | 2174 | 5.1 | 220 | 0.5 |
| Water Year | 182 | 27.0 | 287 | 41.7 | 74 | 10.7 | 941 | 25.7 | 1590 | 44.1 | 368 | 11.09 |

(1) Adjusted for change in storage in Knightville Reservoir since 1943
(2) Adjusted for change in storage in Littleville Reservoir since 1965
(3) Adjusted for change in storage in Knightville, and Cobble Mountain Reservoirs, plus diversion for water supply.

the August 1955 and September 1938 storms are shown on Plate D-6. Water surface profiles for five of the record floods are shown on Plate D-7.

## *FLOOD FREQUENCIES*

Peak discharge frequency analyses consisted of reviewing and updating the 1963 studies by adding subsequent years of flow data. A statistical analysis was made of flow data at Westfield using the natural flow data, from 1915 to 1941, when Knightville dam was placed in operation, and then extending that natural flow record by correlation with the unregulated West Branch flow record through 1975. Analysis was made using a Log Pearson Type III distribution with an adopted skew of 1.0, based on earlier regional analyses. The resulting natural frequency curve is shown on Plate D-12. Annual peak flows recorded at Westfield are listed in Table D-9.

The modified frequency curve at Westfield, with Knightville and Littleville in operation, was computed as a percentage of the natural frequency curve. The percent reduction was based on the computed effect of the projects on a range of floods. An attempt was also made to statistically compute the modified frequency curve at Westfield by correlating the thirteen years of modified data (since completion of Littleville) with the longer term unregulated West Branch record. However, this exercise was generally unsuccessful because not all annual peaks at Westfield are modified by reservoir operation, resulting in a low computed standard deviation which, in turn, results in an exaggerated flood reduction by reservoirs in the rarer flood range. This problem was further amplified by the coincidence that there has been no major flood event since 1969 and the greatest drought of record was experienced during the mid 1960's.

It should not be inferred that the two reservoirs will reduce all floods an equal percentage. The percent reduction will vary with the orientation of the storm over the basin. The modified curve, shown on Plate D-12, is considered to present the average, or typical, reduction for a wide range of storm occurrences.

TABLE D-8

WESTFIELD RIVER FLOODS
WESTFIELD RIVER NEAR WESTFIELD, MASSACHUSETTS
(Drainage Area = 497 Square Miles)

| Event | Rainfall (inches) | Observed Discharge (cfs) | Gage Height (ft) |
|---|---|---|---|
| Nov 1927 | 6 | 42,500 | 25.4 |
| Mar 1936 | 8 | 48,200 | 27.2 |
| Sep 1938 | 10 | 55,500 | 29.4 |
| Dec 1948(1) | 9 | 32,200(3) | 22.0 |
| Aug 1955(1) | 5-19 | 70,300(4) | 34.2 |
| Oct 1955(1) | 7-13 | 31,000(5) | 21.8 |
| Dec 1973(2) | 3 | 12,500(6) | 13.7 |

(1) Modified by Knightville

(2) Modified by Knightville and Littleville

(3) Estimated unmodified peak - 48,000 cfs

(4) Estimated unmodified peak - 77,000 cfs

(5) Estimated unmodified peak - 44,000 cfs

(6) Estimated unmodified peak - 27,800 cfs

TABLE D-9

## ANNUAL PEAK FLOWS OF WESTFIELD RIVER AT WESTFIELD GAGE

| Water Year | Discharge (cfs) | |
|---|---|---|
| 1915 | 22,200 | |
| 1916 | 11,800 | |
| 1917 | 13,000 | |
| 1918 | 7,900 | |
| 1919 | 20,200 | |
| 1920 | 19,200 | |
| 1921 | 16,800 | |
| 1922 | 12,700 | |
| 1923 | 11,100 | |
| 1924 | 32,500 | |
| 1925 | 16,200 | |
| 1926 | 8,880 | |
| 1927 | 9,060 | |
| 1928 | 42,500 | Natural |
| 1929 | 12,600 | |
| 1930 | 7,870 | |
| 1931 | 16,500 | |
| 1932 | 11,900 | |
| 1933 | 34,600 | |
| 1934 | 18,000 | |
| 1935 | 15,800 | |
| 1936 | 48,200 | |
| 1937 | 21,400 | |
| 1938 | 55,500 | |
| 1939 | 12,700 | |
| 1940 | 12,800 | |

| Water Year | Discharge (cfs) | |
|---|---|---|
| 1941 | 7,730 | |
| 1942 | 12,100 | |
| 1943 | 15,000 | |
| 1944 | 11,700 | |
| 1945 | 12,600 | |
| 1946 | 8,130 | |
| 1947 | 8,030 | |
| 1948 | 11,300 | |
| 1949 | 32,200 | |
| 1950 | 5,960 | |
| 1951 | 18,100 | With |
| 1952 | 14,800 | |
| 1953 | 11,200 | Knightville |
| 1954 | 11,900 | |
| 1955 | 70,300 | |
| 1956 | 31,100 | |
| 1957 | 6,140 | |
| 1958 | 8,740 | |
| 1959 | 8,880 | |
| 1960 | 10,300 | |
| 1961 | 8,080 | |
| 1962 | 8,560 | |
| 1963 | 6,840 | |
| 1964 | 5,820 | |
| 1965 | 4,000 | |
| 1966 | 3,380 | |
| 1967 | 4,910 | With |
| 1968 | 8,110 | |
| 1969 | 11,700 | Knightville |
| 1970 | 8,290 | and |
| 1971 | 6,190 | |
| 1972 | 12,100 | Littleville |
| 1973 | 7,870 | |
| 1974 | 12,500 | |
| 1975 | 11,100 | |

## *ANALYSIS OF FLOODS*

The major floods of record in the Westfield River basin, notably the August 1955 and September 1938 events, were analyzed to determine the hydrologic development of the floods and the contribution of various watershed components to the total at Westfield. The selected watershed components were: the Westfield River at Knightville, the Middle Branch, the West Branch, the local area to Elm Street in Westfield, the Little River and the remaining local area contribution to the Westfield gage. The three upper watershed components were routed to Westfield by "Average Lag" and the total inflow to Westfield was routed through floodplain storage at Westfield using a "modified Puls" type of reservoir routing. Analysis of the floodplain storage effect at Westfield is discussed later in this section. Adopted average lag routing coefficients for routing major floods to Westfield, using a 1-hour time interval, were 3-2 for the middle and West Branches and 4-2.5 for the Westfield River at Knightville.

Runoff hydrographs for the ungaged local areas were patterned after the gaged areas with consideration given to: total storm runoff at Westfield, storm rainfall over the areas, and respective watershed characteristics. The effects of the existing flood control projects were assessed by the removal or addition of their respective component hydrographs routed to Westfield. A hydrograph summary for the September 1938 and August 1955 floods at Westfield are shown on Plates D-8 and D-9. It is noted that the September 1938 event represents a storm more or less centered over the entire watershed, whereas, the August 1955 storm was centered over the lower uncontrolled portion of the watershed.

## *STANDARD PROJECT FLOOD (SPF)*

The standard project flood for the Westfield River basin was developed from information presented in Engineering Manual 1110-2-1405 and Civil Engineer Bulletin No. 52-8. In all studies

to date this flood has been adopted as the design flood for Westfield local protection alternatives. The standard project flood is a very intense short duration event resulting in extremely high peak runoff rates from the mountainous Westfield watershed. The flood was developed by applying standard project storm rainfall to selected unit hydrographs.

Standard Project Storm (SPS). The storm was assumed oriented over the basin and average rainfall amounts were determined for a watershed area of 500 square miles. Infiltration and other losses were assumed at a minimum of 0.07 inches per hour. The 24-hour storm volume averaged 8.80 inches and losses totalled 1.40 inches yielding a rainfall excess of 7.40 inches. It is noted that though the total storm excess was only 7.4 inches, a phenomenal 5.7 inches occurred in a 3-hour period. Such intensity would produce extremely high runoff rates in the Westfield watershed. Though the August 1955 storm produced large volume rainfall, peak rates of rainfall generally did not exceed 3 inches per 3-hour period. A tabulation of the 3-hour standard project storm rainfall, losses and excess is shown in Table D-10.

Unit Hydrographs. Unit hydrographs were developed for the component watersheds by analysis of recorded historic floods at the gaging stations on the Middle Branch, West Branch and Westfield River at Knightville. The unit hydrographs having the maximum peak ordinate were generally adopted for the development of the standard project flood. Unit graphs for the ungaged local areas are patterned after those for the gaged areas with adjustment for varying watershed characteristics. Adopted unit hydrographs are shown on Plate D-10.

Flood Development. The standard project flood at Westfield was developed by applying the standard project storm rainfall to the developed unit hydrographs. Inflow hydrographs were routed through reservoir storage at Knightville, Littleville and Cobble Mountain reservoirs. Outflows were then routed downstream and combined with local contributions at Westfield. The total inflow at Westfield was then routed through floodplain storage at Westfield to determine peak stage and outflow from the Westfield floodplain.

Cobble Mountain reservoir was assumed initially filled to spillway crest and the flood was routed through surcharge storage. Full flood control storage was assumed initially available at Knightville and Littleville. River routings were made using average-lag coefficients developed from analysis of the August 1955 flood. The SPF component hydrographs are illustrated on Plate D-11.

TABLE D-10

STANDARD PROJECT STORM RAINFALL
WESTFIELD RIVER BASIN

| Time | Rainfall (inches) | Losses 0.07 Inches per Hour (inches) | Rainfall Excess (inches) | Rainfall Rearranged (inches) |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 3 | 5.92 | 0.21 | 5.71 | 0.05 |
| 6 | 1.48 | 0.21 | 1.27 | 0.11 |
| 9 | 0.47 | 0.21 | 0.26 | 1.27 |
| 12 | 0.32 | 0.21 | 0.11 | 5.71 |
| 15 | 0.26 | 0.21 | 0.05 | 0.26 |
| 18 | 0.18 | 0.18 | 0 | 0 |
| 21 | 0.14 | 0.14 | 0 | 0 |
| 24 | 0.03 | 0.03 | 0 | 0 |
| Total | 8.80 | 1.40 | 7.40 | 7.40 |

# EFFECT OF RESERVOIRS

Knightville and Littleville. Knightville and Littleville flood control reservoirs control the flood runoff from 32 and 10 percent of the watershed at Westfield, respectively. The effectiveness of the reservoirs varies depending on the orientation of the flood producing storm over the watershed. Effectiveness was analyzed by studying major historic floods and the synthetic standard project flood, both with and without the two projects. The projects would reduce a September 1938 type flood, whose storm was centered over the watershed, from a flow of 81,000 cfs at Elm Street in Westfield to about 47,000 cfs. Assuming no Westfield local protection, the reservoirs would reduce the outflow at the Westfield gage from 55,500 cfs to about 36,000 cfs. With an August 1955 flood, whose storm was centered over the lower basin, Knightville reduced the flow at Elm Street from 82,000 to 70,000 cfs and at the gage from 77,000 to 70,300 cfs. The addition of Littleville further reduces the flow to 56,000 cfs at Elm Street and 62,500 cfs at the gage.

With the standard project storm centered over the basin the two reservoirs reduced the resulting flow at Elm Street from 171,000 to 85,500 cfs and at the USGS gage from 136,000 to 89,000 cfs. Littleville has ample storage to control the standard project flood runoff. Knightville fills and spills but the spillage occurs during flood recession and does not contribute significantly to peak flows at Westfield.

The effects of Knightville and Littleville on the 1938, 1955 and SPF floods are illustrated in Tables D-11, D-12, and D-13 and on Plates D-8, D-9 and D-11.

Though the effectiveness of the two projects varies with storm orientation, major floodflows, on the average, are reduced about 52 percent at Elm Street and 42 percent at the Westfield gage by the two projects.

Cobble Mountain. Cobble Mountain reservoir has no storage capacity reserved for flood control. However, surcharge storage at the project serves to desynchronize the runoff from its watershed with that from downstream uncontrolled areas. The

TABLE D-11

EFFECT OF FLOOD CONTROL PROJECTS
ON FLOODS IN THE WESTFIELD RIVER

Water Surface Elevations (msl) and Discharge(cfs)
of Westfield River at U.S. Geological Survey
Gaging Station near Westfield, Massachusetts

| | | Modified by Flood Control Projects | | |
|---|---|---|---|---|
| Frequency (years) | Natural | Knightville & Littleville Reservoirs Only | Interim Report LPP Plan | Proposed LPP Plan |
| 10 | 121.1 (34,000) | 116.1 (21,000) | 116.1 (21,000) | 116.1 (21,000) |
| 30(a) | 128.2 (55,500) | 121.3 (34,800) | 121.5 (35,200) | 121.7 (35,500) |
| 30(b) | 128.2 (55,500) | 121.4 (35,000) | 121.7 (35,500) | 121.9 (36,000) |
| 80(c) | 134.0 (77,000) | 125.5 (47,000) | 126.0 (48,500) | 126.5 (50,000) |
| 80(d) | 134.0 (77,000) | 130.2 (62,500) | 131.2 (66,000) | 131.5 (67,000) |
| SPF | 149.0 (136,000) | 137.5 (89,000) | 139.8 (98,000) | 140.5 (101,000) |

(a) Hypothetical flood similar in magnitude to September 1938 flood but developing uniformly over the entire Westfield River basin.

(b) September 1938 flood as experienced with storm centered over the central portion of the basin.

(c) Hypothetical flood similar in magnitude to August 1955 flood but developing uniformly over the entire Westfield River basin.

(d) August 1955 flood (without Knightville Reservoir) with storm centered in southern part of basin resulting in minimum effectiveness of reservoirs.

TABLE D-12

## EFFECT OF FLOOD CONTROL PROJECTS ON FLOODS IN THE WESTFIELD RIVER

Water Surface Elevations (msl) of Westfield River Upstream of East Main Street Bridge

| | | Modified by Flood Control Projects | | |
|---|---|---|---|---|
| Frequency (years) | Natural | Knightville & Littleville Reservoirs Only | Interim Report LPP Plan | Proposed LPP Plan |
| 10 | 124.8 | 120.2 | 120.2 | 120.2 |
| 30[a] | 131.6 | 125.2 | 125.4 | 125.6 |
| 30[b] | 131.6 | 125.4 | 125.6 | 125.8 |
| 80[c] | 136.8 | 129.2 | 129.6 | 130.0 |
| 80[d] | 136.8 | 133.6 | 134 4 | 134.7 |
| SPF | 150.0 | 140.0 | 142.0 | 142.4 |

(a) Hypothetical flood similar in magnitude to September 1938 flood but developing uniformly over the entire Westfield River basin.

(b) September 1938 flood as experienced with storm centered over the central portion of the basin.

(c) Hypothetical flood similar in magnitude to August 1955 flood but developing uniformly over the entire Westfield River basin.

(d) August 1955 flood (without Knightville Reservoir) with storm centered in southern part of basin resulting in minimum effectiveness of reservoirs.

TABLE D-13

## EFFECT OF FLOOD CONTROL PROJECTS ON FLOODS IN THE WESTFIELD RIVER

Water Surface Elevations (msl) and Discharge (cfs)
of Westfield River Upstream of Elm Street Bridge

| Frequency (years) | Natural | Modified by Knightville and Littleville Reservoirs and Local Protection Project |
|---|---|---|
| 10 | 138.6<br>(32,000) | 132.8<br>(13,600) |
| 30 | 144.8<br>(62,000) | 137.8<br>(28,800) |
| 50(a) | 147.6<br>(81,000) | 140.2<br>(38,600) |
| 50(b) | 147.6<br>(81,000) | 142.0<br>(47,000) |
| 50(c) | 147.8<br>(82,000) | 143.8<br>(56,000) |
| 80 | 151.2<br>(104,000) | 142.8<br>(50,500) |
| SPF | 159.0<br>(171,000) | 148.0<br>(85,500) |

(a) Hypothetical flood similar in magnitude to September 1938 and August 1955 floods but developing uniformly over the entire Westfield River basin.

(b) September 1938 flood as experienced with storm centered over the central portion of the basin.

(c) August 1955 flood (without Knightville Reservoir) with storm centered in southern part of basin resulting in minimum effectiveness of reservoirs.

effect of Cobble Mountain on flood runoff from the Little River for the 1955 and SPF floods is illustrated on Plates D-9 and D-11.

SCS Reservoirs. The two existing SCS detention reservoirs in the Powdermill Brook watershed have a total combined watershed of only eight square miles, or 1.6 percent of the total watershed of the Westfield River at the Westfield gage. Also the combined storage capacity of 1,547 acre-feet is equivalent to 3.7 inches of runoff. Therefore, though the projects reduce peak flows in Powdermill Brook, they have a negligible effect on peak flows on the mainstem Westfield River or on the resulting backwater flood levels on Powdermill Brook in Westfield.

In analyzing floods at Westfield the storage capacity of the two SCS Projects on Powdermill Brook was combined with the Westfield flood plain storage. This analysis is discussed later in this section.

The SCS system of eleven proposed retention reservoirs in the West Branch, if completed, would effect the runoff from 33.4 square miles, which is 35 percent of the West Branch watershed and 6.7 percent of the Westfield River watershed at the Westfield gage. The system would have a total storage capacity of 9,630 acre-feet, equivalent to 5.5 inches of runoff. Based on a very general flood routing analysis, this system would reduce the modified standard project flood flow at Elm Street an estimated fifteen percent and at the Westfield gage an estimated nine percent. This would effect a stage reduction of about 2.0 and 2.5 feet at Elm Street and the Westfield gage, respectively.

## *EFFECT OF FLOOD PLAIN STORAGE*

A large area in the eastern section of the city of Westfield is a natural flood plain that becomes inundated during flood periods. The flood plain upstream of the Westfield USGS gage, including backwater areas on Powdermill Brook, Great Brook and the Little River, covers an area of nearly 2,000 acres under flood of record conditions. It is estimated that water temporarily stored on this plain during the August 1955 flood amounted to about 18,000 acre-feet of storage, equivalent to 1.4 inches of runoff from the net watershed of 335 square miles (excluding Knightville watershed). During major short duration floods such flood plain storage can have a significant modifying effect on peak flood

outflows. The effect of such storage was studied by routing floods through Westfield using a "modified Puls" type reservoir routing. Inflow to Westfield includes the Westfield River (at Elm Street), the Little River, and the remaining local area. It is estimated that during the 1955 flood of record these three components produced a peak inflow to storage of about 116,000 cfs. The peak outflow was 70,000 cfs. The synthetic standard project flood, modified by Knightville and Littleville, would be reduced from a peak inflow of 144,000 cfs to an outflow of 89,000 cfs.

The local protection projects under study for Westfield would eliminate approximately 1,000 acres of flood plain area, under SPF conditions, thereby reducing the amount of effective flood plain storage. The loss of flood plain storage was considered comparable for either the "NED" or "EQ" Plans. Loss of such storage would tend to increase peak outflows downstream resulting in an increase in stage. The modified peak outflow of a 1955 type flood would be increased from about 62,500 to 67,000 cfs and the SPF would be increased from 89,000 to 101,000 cfs. Summaries of the effects of flood plain storage at Westfield is presented in Tables D-11 and D-12. The effect of the loss of storage on the downstream flood profile is illustrated on Plate D-14.

It is noted that though the local protection project would produce some increase in downstream stages during large infrequent floods, the net effect of both the upstream Corps reservoirs and a local protection project is still a substantial reduction for all floods.

## *FLOOD PROFILES*

The original project design flood profiles, reported in 1963, were determined by backwater computations using the "step-method" as outlined in EM 1110-2-1409, "Backwater Curves in River Channels." Computed profiles were also compared with observed flood profiles with regard to hydraulic losses.

In current studies, supplemental backwater studies were performed, using the HEC-2 computer program, to determine the effects of changes in the plans of protection. Computations were made with a minimum of surveyed cross sections using a Manning's "n" of 0.035 for channel and 0.050 for overbank areas. Expansion

and contraction coefficients were 0.3 and 0.1, respectively. Computations commenced at the Westfield USGS gage where starting water surface elevations could be determined from the established stage-discharge rating.

For the "EQ Plan", with protection on both sides of the Westfield River, the design water surface above Elm Street would be raised approximately three feet above the original 1963 design level for the "NED Plan". With the Little River pressure conduit, considered in the "EQ Plan", the design water surface at the site of the entrance would be 2.5 feet higher than with the "NED Plan".

The design flood profile on Powdermill Brook for the "EQ Plan" of protection, is governed largely by backwater from the Westfield River except at the upstream end in the vicinity of the proposed Powdermill Brook pressure conduit.

Design profiles were based on design flood flows of 101,000 cfs in the lower Westfield River, 28,000 cfs in the Little River, 4,500 cfs on Powdermill Brook and 85,000 cfs on the upper Westfield River. Design profiles are shown on Plates D-3 and D-13. Variations in elevations between the "NED" and "EQ" plans are noted on Plate D-13

## *VELOCITIES*

Flow velocities in the lower reaches of the Westfield River, Little River, and Powdermill Brook would be affected, under design flood conditions, by backwater from the flat gradient of the Westfield River in the downstream flood plain. Therefore, maximum velocities would occur at less than design flow when backwater is minimal. Computations indicated that maximum velocities on the Westfield and Little Rivers generally ranged from six to twelve feet per second. These velocities would occur in the river channel and since the toe of the protective dikes would be located on a berm a distance from the channel, the velocity adjacent to the dikes would be considerably less than in the river channel. All relocated river sections and exposed dikes would have riprap slope protection against erosive velocities.

Velocities on the lower reach of Powdermill Brook are low, generally not exceeding two to three feet per second, due to the relatively flat gradient of about 0.2 percent. Velocities in the upper reach of the brook generally would not exceed five to ten feet per second.

## *RIPRAP PROTECTION*

Tractive forces on streambanks and dikes in the Westfield area are generally low due to the hydraulic character of the flood plain and flat stream gradients. However, because Westfield is an urban area, the riverward side of all dikes and the banks of relocated river sections would be protected with riprap having a design $D_{50}$ minimum of 0.5 feet, thus insuring a stone size and layer thickness adequate to minimize vandalism. Special riprap considerations would be applied to the Little River bypass during final design due to its relatively steep slope of about 0.6 percent.

## *FREEBOARD*

Freeboard is the vertical distance measured from the design water surface to the top of dike or wall. Freeboard is provided to insure that the desired degree of protection will not be reduced by unaccounted factors. Three feet of freeboard was adopted for all earthen dikes under study for Westfield, except along the Westfield River upstream of Elm Street where four feet was adopted. Added freeboard was adopted in this reach because of hydraulic complexities in the area of Elm Street and the increased need for dike safety in upstream areas of a project.

Two feet of freeboard was adopted for concrete walls due to their greater resistance to failure if some overtopping were to occur.

## *LITTLE RIVER CONDUIT*

In studies for the "EQ Plan", consideration was given to placing the lower 1,200 feet of the Little River bypass in a pressure conduit, comprised of three 26 feet high by 25 feet wide passageways. A pressure conduit was considered in lieu of the open channel to avoid the relocation or new developments in the channel alignment near Little River Road, particularly a new bank building.

The pressure conduit was analyzed for two flow conditions. The first condition was with a peak flow of 28,000 cfs on the Little River with the coincident tailwater of 132.2 feet msl on the Westfield River, and the second was with a peak flow of 20,000 cfs on the Little River with the peak tailwater of the Westfield at 144 feet msl. The latter condition was found most critical for determining maximum hydraulic gradient through the conduit and in the upstream bypass channel. With a flow of 20,000 cfs the velocity in the conduit would be ten feet per second and the total head loss through the structure would be 3.6 feet, made up of an entrance loss of 0.9 feet, a friction loss of 1.1 feet and an exit loss of 1.6 feet. The location and sections of the conduit are shown on Plates D-3 and D-4.

## *POWDERMILL BROOK CONDUIT*

The "EQ Plan" includes 800 feet of pressure conduit on Powdermill Brook in the vicinity of Highway Route 202, due to insufficient space between buildings for a dike, and to avoid the need for a street gate. The pressure conduit would have two eight feet high by nineteen feet wide passageways, sized to convey the estimated SPF spillage of 4,500 cfs from the upstream SCS reservoirs with a coincident Westfield tailwater of 140 feet msl. The conduit would have a design flow velocity of fifteen feet per second and a total head loss of about ten feet. With the design Westfield tailwater of 146 feet msl the conduit would have a

capacity of about 3,000 cfs with the total head loss not exceeding four feet. The design tailwater at the outlet of the conduit was considered 146 feet above msl, two feet above the design backwater level of the Westfield River at the mouth of the brook.

## *LOW FLOW PASSAGES*

At the request of environmental and conservation interests, consideration was given in "EQ Plan" studies to providing low flow passages through the lines of protection in order to maintain flow in the existing Little and Westfield River sections that would lie within the protected area if the project were built. The inclusion of such flow passages would be a detriment to the flood control integrity of the project, however, the structures were sized to pass the estimated average summer flow, which was assumed equal to one-half the all-season average annual flow, with a depth of flow in the river of between three and four feet. The selected discharges were fifty cfs inflow on the Little River, 250 cfs inflow on the Westfield River and a resul ing 300 cfs outflow on the Westfield River. The gates and passageways were sized for a velocity of about three feet per second with the adopted discharges, resulting in the following gate sizes:

| | |
|---|---|
| Little River Inflow | -Two 4 ft x 4 ft gates |
| Westfield River Inflow | -Three 4 ft high x 8 ft wide gates |
| Westfield River Outflow | -Four 4 ft high x 8 ft wide gates |

## *INTERIOR DRAINAGE*

"NED Plan" Requirements. For a detailed description and analysis of the interior drainage for the "NED Plan" of protection, reference is made to the 1963 Design Memorandum No. 1 for the then authorized Westfield local protection project. The interior drainage area of the "NED Plan" is approximately 2,320 acres. The area was subdivided into five separate subareas with

individual storage ponds and gravity outfalls through the dikes. The five ponding areas were namely:

Upper and Lower Riverside Ponding Area

Shepard Street Ponding Area

South Meadow Road Ponding Area

East Main Street Ponding Area

One 176 cfs pumping station was provided at the East Main Street area to facilitate maintaining design ponding levels to about elevation 120 feet msl, but more importantly, the pump was installed to facilitate emptying the large East Main Street storage area within a reasonable period of time following flood events to protect against possible damages from long duration or a sequence of storm events. The 176 cfs capacity was equivalent to a runoff rate of about 0.1 inch per hour from the 1,500 acre drainage area.

"EQ Plan" Requirements. In the development of the "EQ Plan" of protection the dike along the south side of the Westfield River was moved landward to reduce the amount of encroachment of flood plain storage and offset the loss of flood plain by the addition of the "EQ Plan" of protection on the north side of the Westfield River. This dike realignment resulted in less flood plain encroachment but resulted in about a sixty percent loss in the East Main Street interior ponding area provided in the "NED Plan". In order to maintain comparable design levels of interior ponding and criteria, the East Main Street pumping station was increased to 500 cfs to offset the loss in ponding capacity. A capacity of 500 cfs is equivalent to a runoff rate of 0.3 inch per hour from the 1,500 acre drainage area.

The "EQ Plan" of protection for the north side of the Westfield River resulted in the need for a second pumping station. This "north side" protection would have an interior drainage area of about 300 acres. Drainage would be to the east and would be discharged to Powdermill Brook via a pumping station located at the easterly end of the protected area. Using the originally adopted "NED" design criteria, and assuming three acres would be preserved at the station for ponding up to three feet in depth, a pumping capacity of 160 cfs was selected for costing purposes. This capacity is equivalent to a runoff rate of 0.5 inch per hour from the 300 acre drainage area.

Pumping station sites and ponding areas are shown for the

"NED" and "EQ" plans on Plates D-2 and D-3. Comparative pumping requirements for the two plans are shown in Table D-14.

Design Criteria. A higher than normal interior drainage design criteria was adopted in 1963 because of the very flashy nature of the Westfield River and the fact that substantial rates of rainfall have occurred concurrently with flood stages in the Westfield and Little Rivers during historic flood events. Because of this characteristic, interior drainage ponding areas were designed for a 20-year frequency rainfall-runoff coincident with flood stages in the rivers. Gravity outfalls were sized to discharge the 100-year frequency storm runoff with normal river stages. For current comparative planning studies, the original 1963 design criteria was retained. If a decision is made to proceed with design of the "EQ", "NED", or any other plan, then further interior drainage analyses would be required in the preparation of a new feature Design Memorandum.

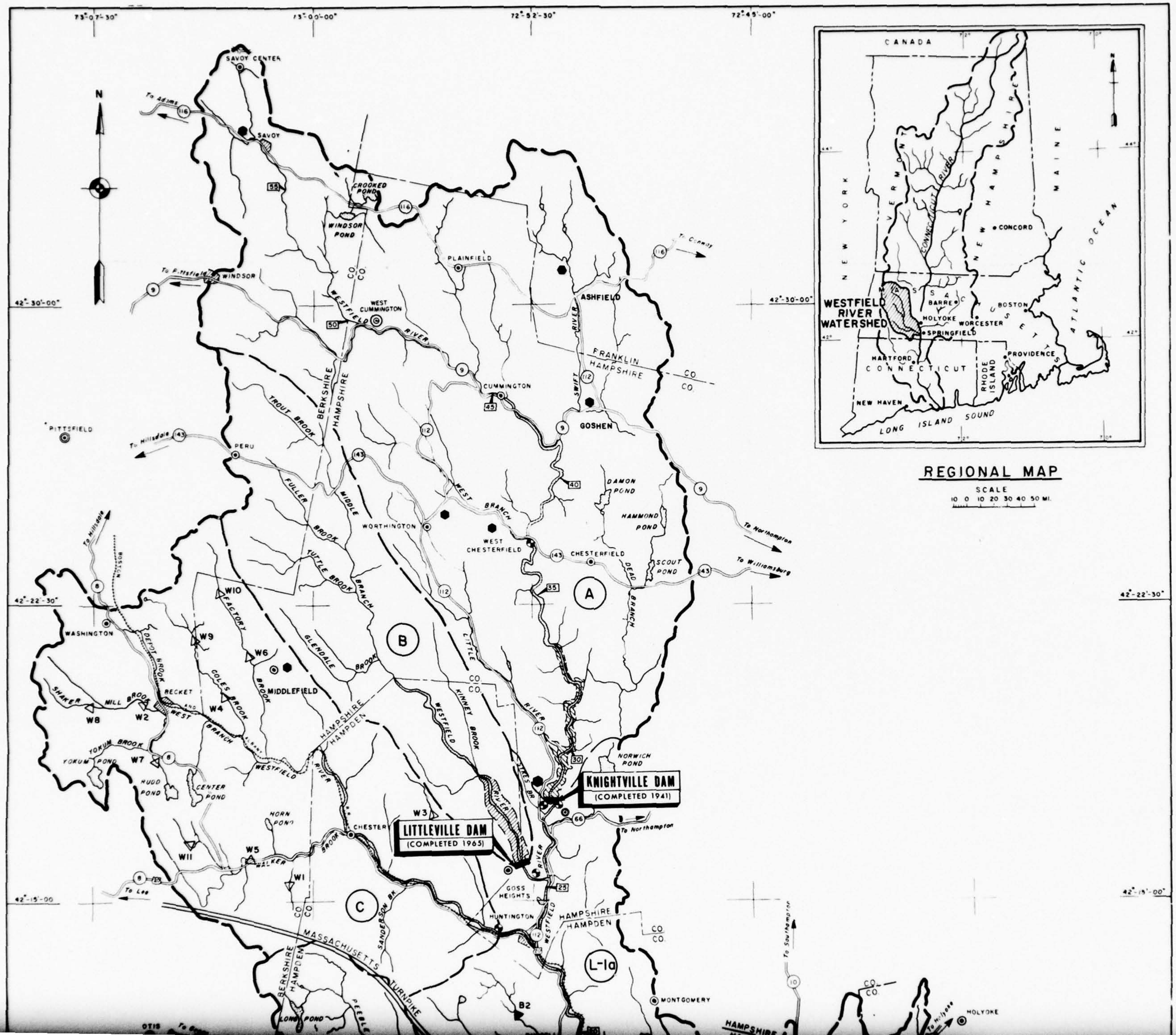
## *OPERATIONAL CONSIDERATIONS*

Due to the flashy nature of the Westfield River, flooding can develop within a two to three hour period after intense rainfall. Therefore, operational requirements are an important consideration in any flood control plan for Westfield. The "NED Plan" would require less manpower than the "EQ Plan" since it would have less street gates, sluice gates and pumping stations which require operation during flooding.

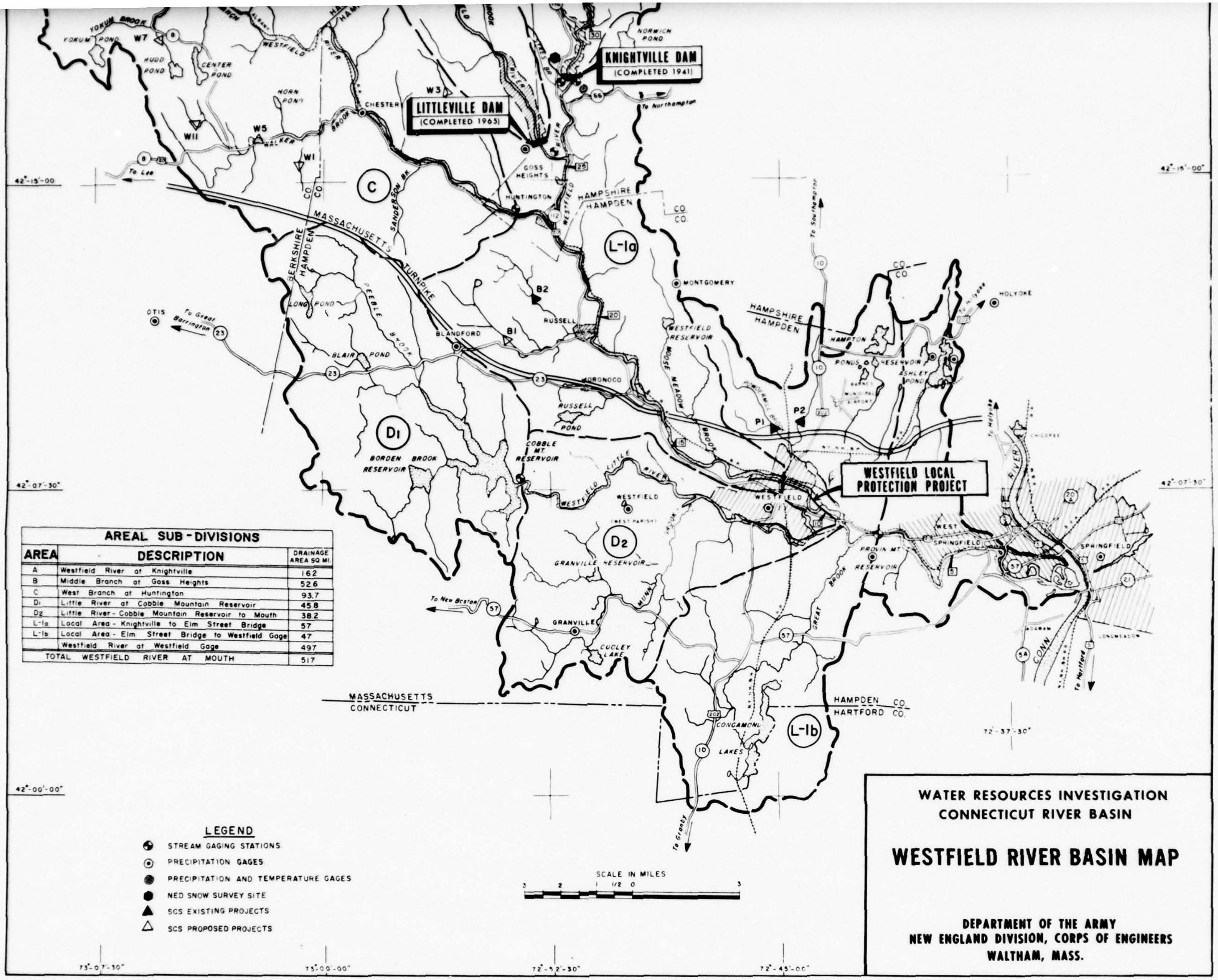
TABLE D-14

COMPARATIVE PUMPING REQUIREMENTS

| Station | NED Plan | EQ Plan |
|---|---|---|
| East Main Street Station | 176 cfs | 500 cfs |
| Union Street Station | None | 160 cfs |



REGIONAL MAP
SCALE
10 0 10 20 30 40 50 MI.
WESTFIELD RIVER WATERSHED
CANADA
NEW YORK
VERMONT
NEW HAMPSHIRE
MAINE
MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
ATLANTIC OCEAN
LONG ISLAND SOUND
CONNECTICUT RIVER
CONCORD
BOSTON
BARRE
HOLYOKE
WORCESTER
SPRINGFIELD
PROVIDENCE
HARTFORD
NEW HAVEN
KNIGHTVILLE DAM
(COMPLETED 1941)
LITTLEVILLE DAM
(COMPLETED 1965)
SAVOY CENTER
SAVOY
CROOKED POND
WINDSOR POND
WINDSOR
PLAINFIELD
ASHFIELD
WEST CUMMINGTON
CUMMINGTON
GOSHEN
PITTSFIELD
PERU
WORTHINGTON
WEST CHESTERFIELD
CHESTERFIELD
DAMON POND
HAMMOND POND
SCOUT POND
NORWICH POND
WASHINGTON
BECKET
MIDDLEFIELD
CHESTER
HORN POND
CENTER POND
HUDD POND
YOKUM POND
GOSS HEIGHTS
HUNTINGTON
MONTGOMERY
FRANKLIN
HAMPSHIRE
BERKSHIRE
HAMPDEN
MASSACHUSETTS TURNPIKE
WESTFIELD RIVER
SWIFT RIVER
WEST BRANCH
MIDDLE BRANCH
LITTLE RIVER
DEAD BRANCH
TROUT BROOK
FULLER BROOK
TUTTLE BROOK
GLENDALE BROOK
FACTORY BROOK
COLES BROOK
DEPOT BROOK
SHAKER MILL BROOK
YOKUM BROOK
KINNEY BROOK
WALKER BROOK
SANDERSON BK
LONG POND
PEEBLE
To Adams
To Pittsfield
To Hillsdale
To Conway
To Northampton
To Williamsburg
To Southampton
To Holyoke
To Lee
A
B
C
L-1a
B2
W1
W2
W3
W4
W5
W6
W7
W8
W9
W10
W11
N
73°-07'-30"
73°-00'-00"
72°-52'-30"
72°-45'-00"
42°-30'-00"
42°-22'-30"
42°-15'-00"



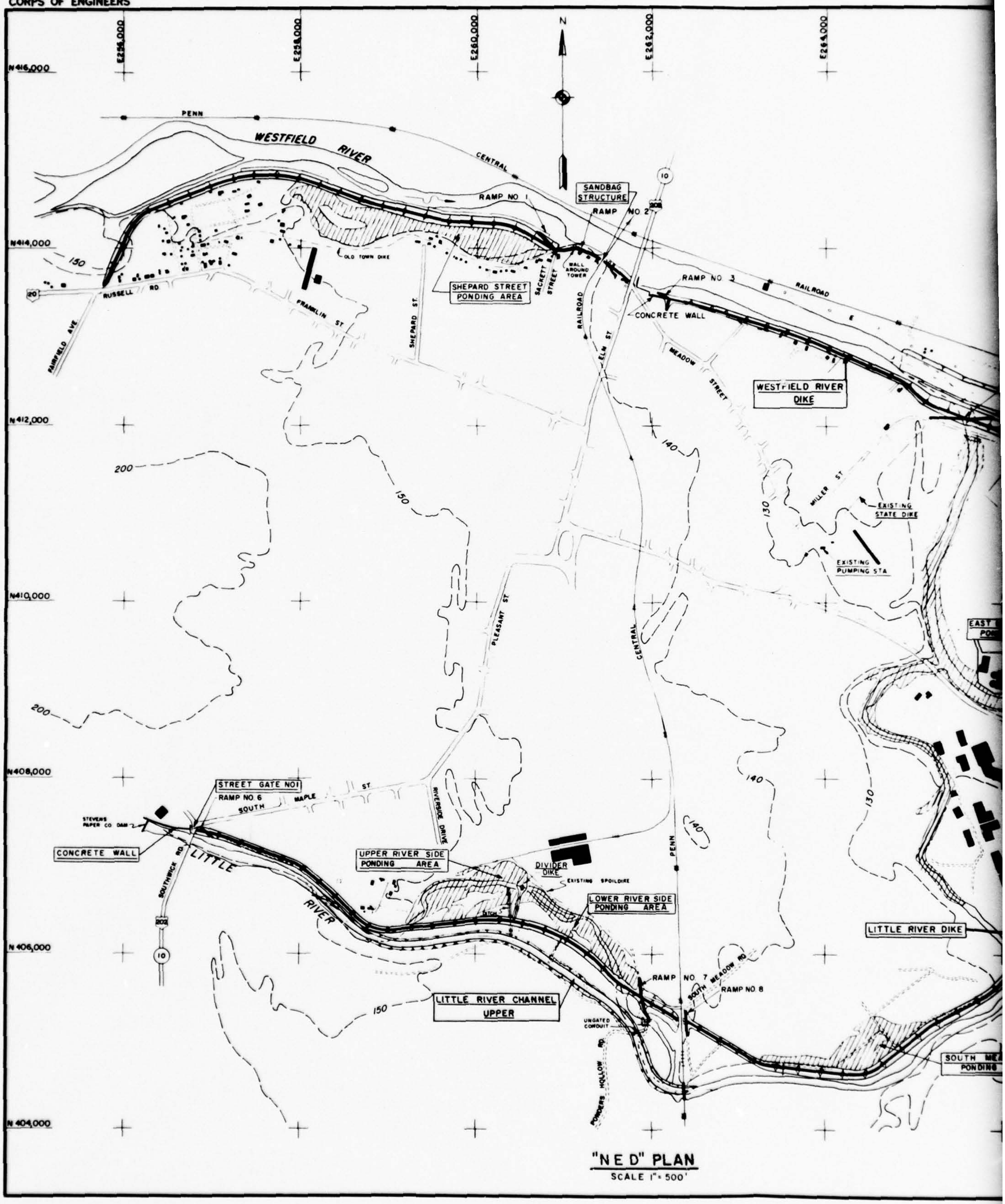

AREAL SUB-DIVISIONS

| AREA | DESCRIPTION | DRAINAGE AREA SQ. MI. |
|---|---|---|
| A | Westfield River at Knightville | 162 |
| B | Middle Branch at Goss Heights | 52.6 |
| C | West Branch at Huntington | 93.7 |
| D1 | Little River at Cobble Mountain Reservoir | 45.8 |
| D2 | Little River - Cobble Mountain Reservoir to Mouth | 38.2 |
| L-1a | Local Area - Knightville to Elm Street Bridge | 57 |
| L-1b | Local Area - Elm Street Bridge to Westfield Gage | 47 |
| | Westfield River at Westfield Gage | 497 |
| | TOTAL WESTFIELD RIVER AT MOUTH | 517 |

PLATE D-1

2

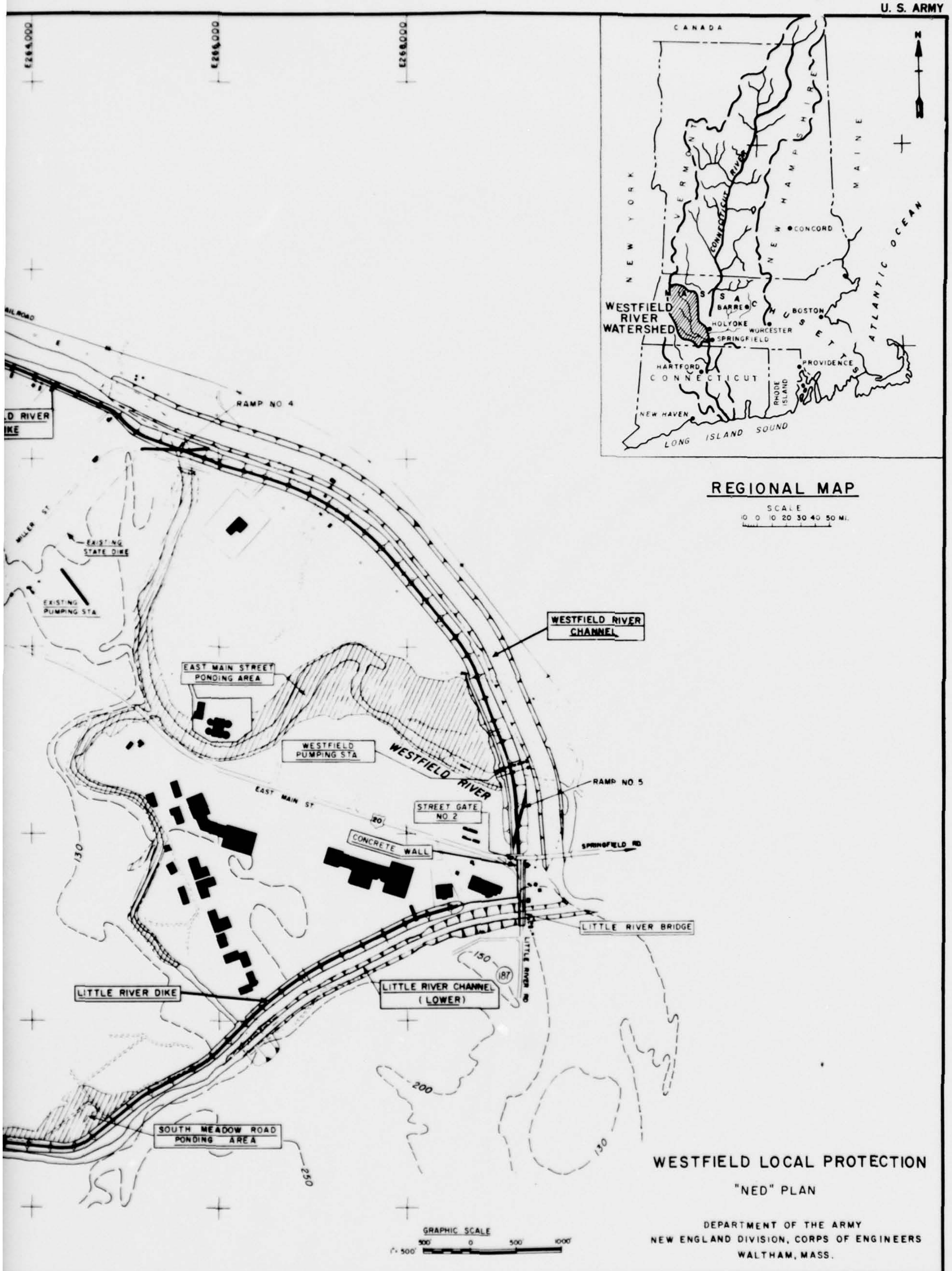
CORPS OF ENGINEERS




"N E D" PLAN
SCALE 1" = 500'

2

U. S. ARMY

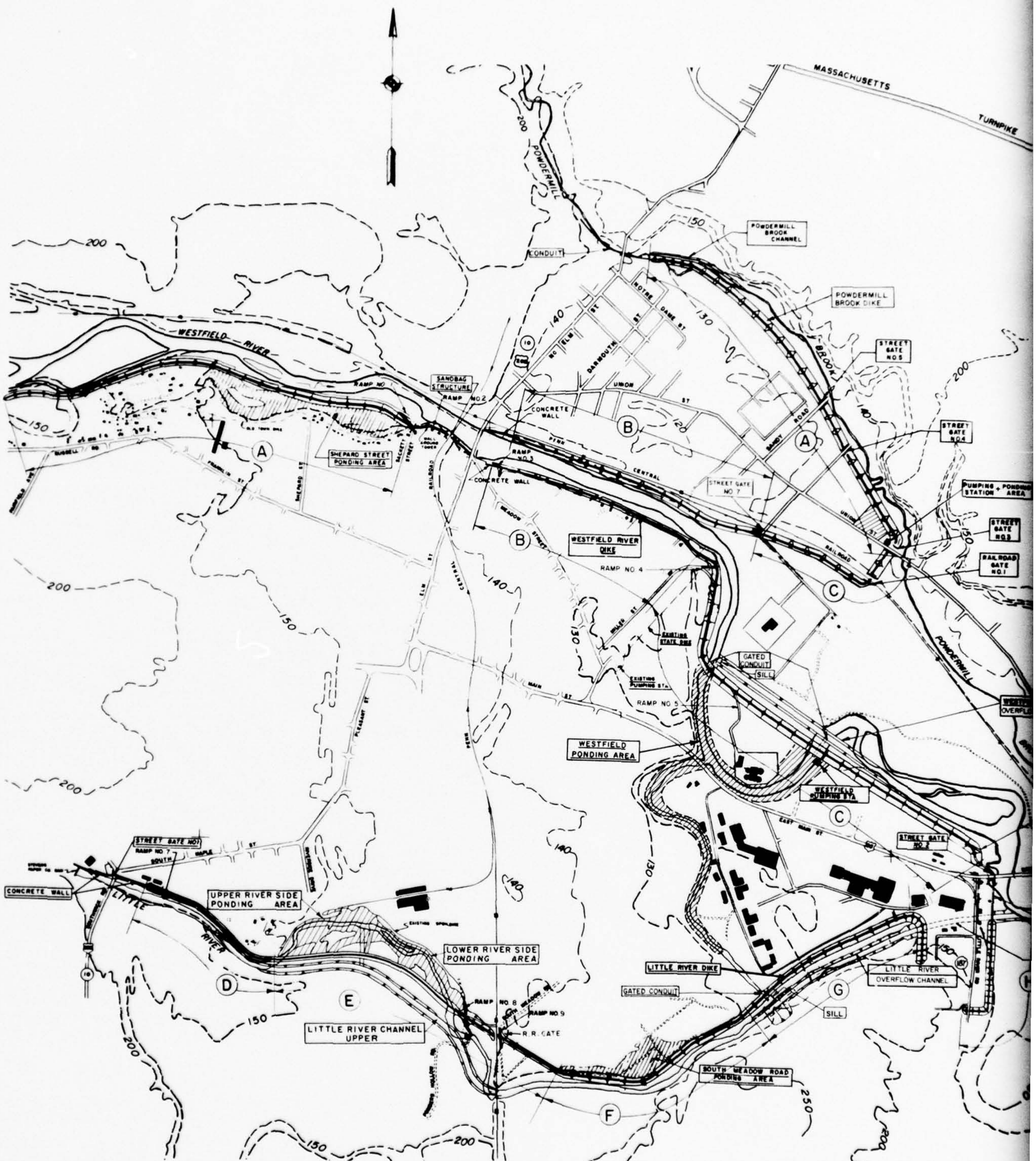



WESTFIELD LOCAL PROTECTION

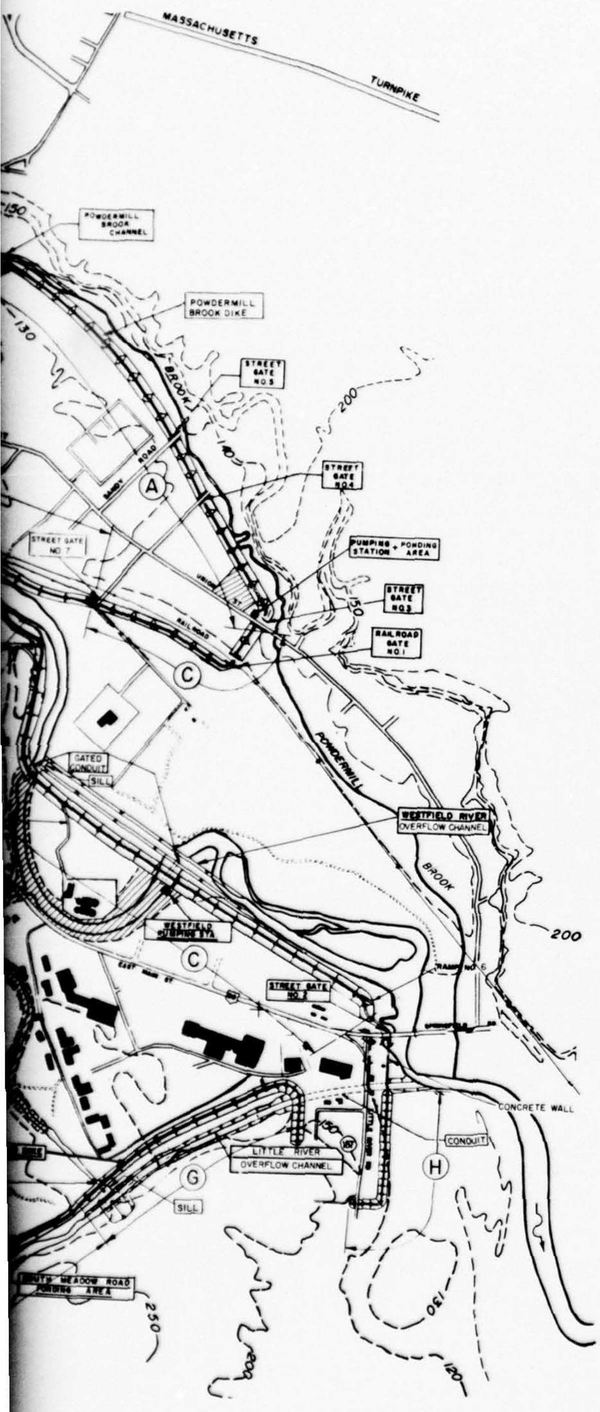
"NED" PLAN

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE D-2

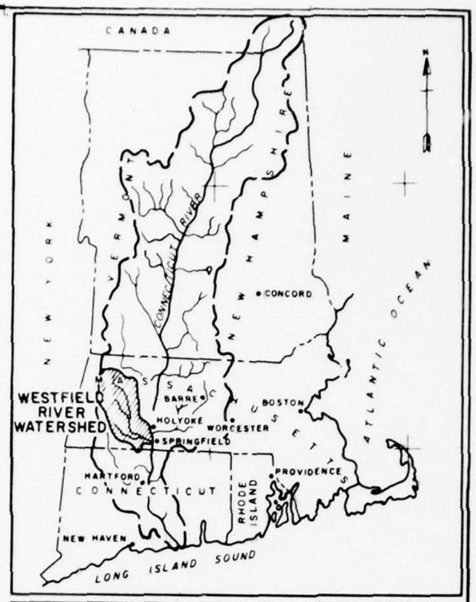

MASSACHUSETTS TURNPIKE
POWDERMILL
CONDUIT
POWDERMILL BROOK CHANNEL
POWDERMILL BROOK DIKE
WESTFIELD RIVER
SANDBAG STRUCTURE
RAMP NO 2
CONCRETE WALL
STREET GATE NO 5
STREET GATE NO 4
SHEPARD STREET PONDING AREA
RAMP NO 3
CONCRETE WALL
STREET GATE NO 7
PUMPING STATION + PONDING AREA
STREET GATE NO 3
RAILROAD GATE NO 1
WESTFIELD RIVER DIKE
RAMP NO 4
GATED CONDUIT
SILL
RAMP NO 5
WESTFIELD PONDING AREA
WESTFIELD PUMPING STA
STREET GATE NO 2
STREET GATE NO 1
RAMP NO 7
CONCRETE WALL
UPPER RIVER SIDE PONDING AREA
LOWER RIVER SIDE PONDING AREA
LITTLE RIVER
LITTLE RIVER DIKE
GATED CONDUIT
LITTLE RIVER OVERFLOW CHANNEL
SILL
RAMP NO 8
RAMP NO 9
R.R. GATE
LITTLE RIVER CHANNEL UPPER
SOUTH MEADOW ROAD PONDING AREA
A
B
C
D
E
F
G

"E Q" PLAN



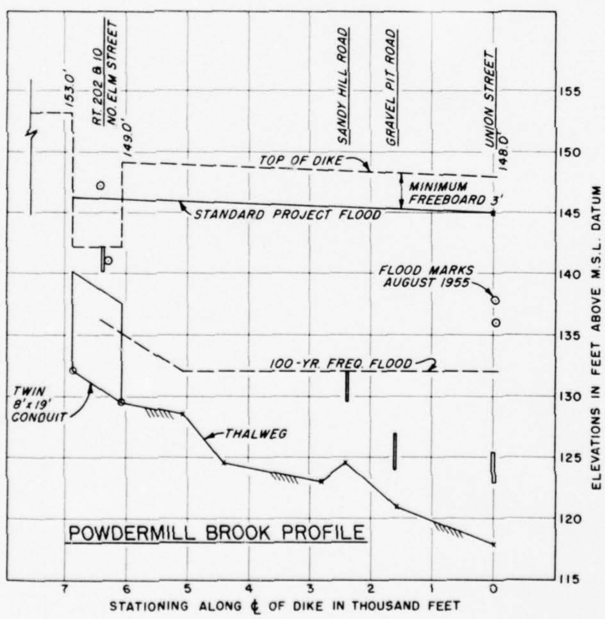

"E Q" PLAN

SCALE IN FEET
1000 500 0 1000




REGIONAL MAP

SCALE
10 0 10 20 30 40 50 MI.



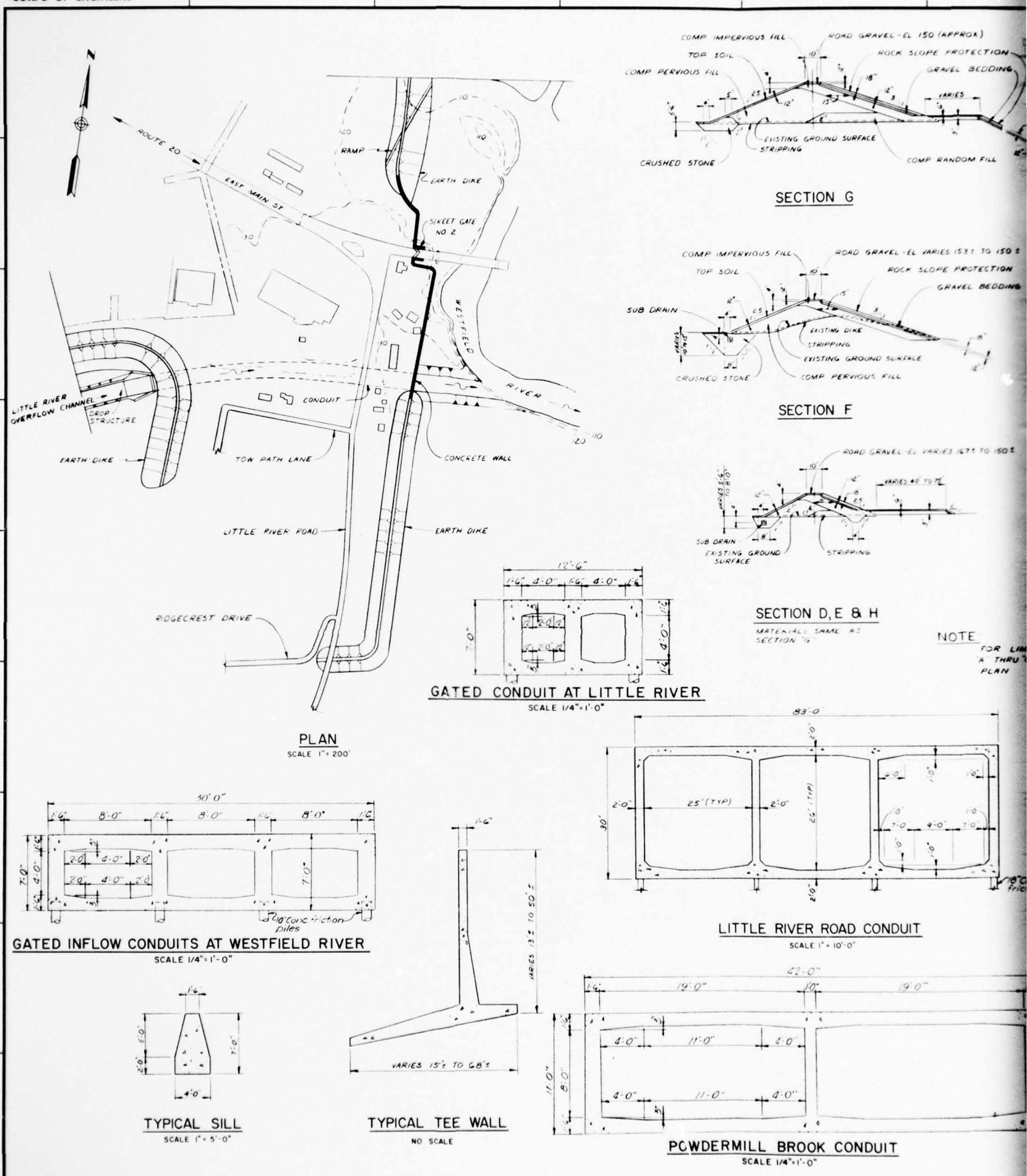

**WESTFIELD LOCAL PROTECTION**

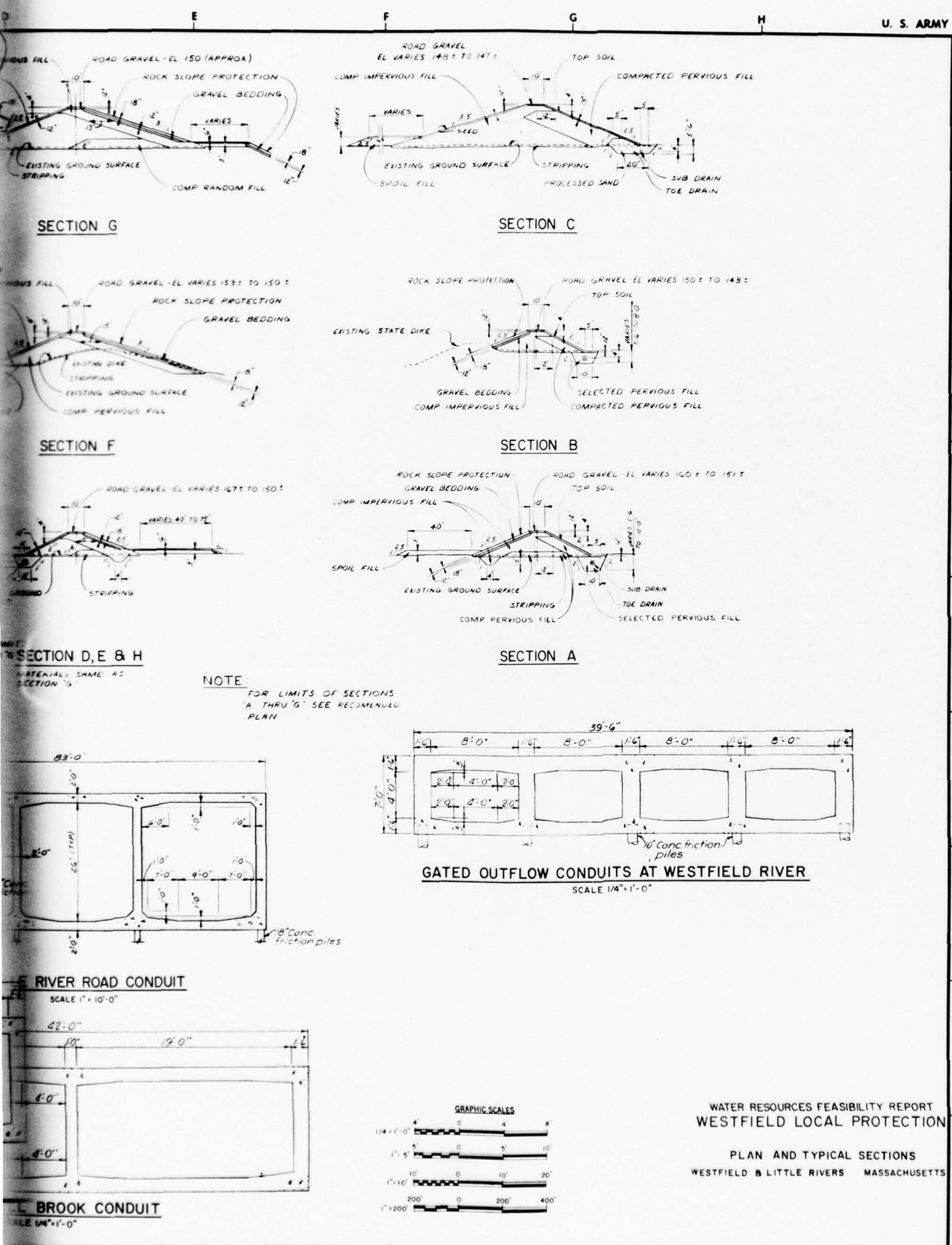
"EQ" PLAN

MAY 1978

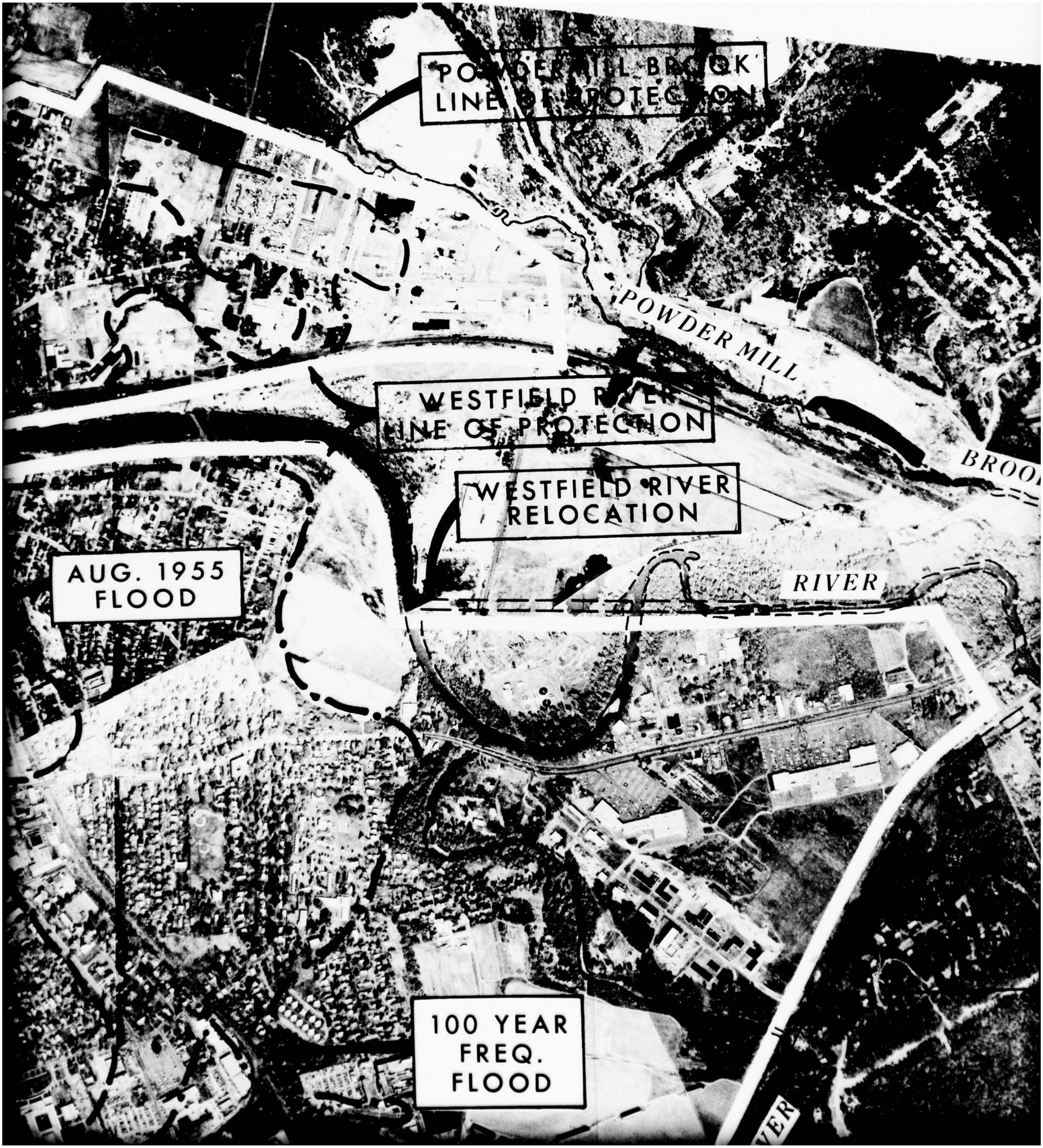
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

CORPS OF ENGINEERS



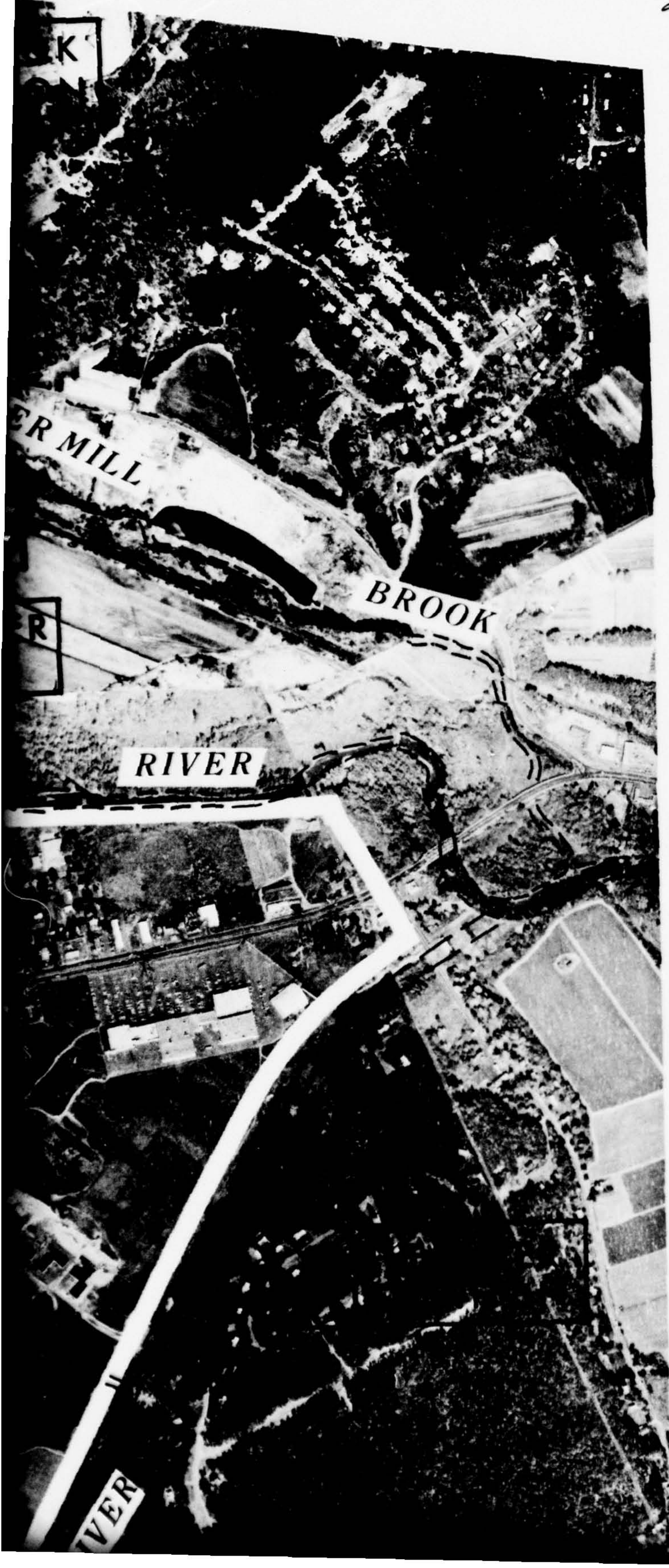

U. S. ARMY
ROAD GRAVEL - EL 150 (APPROX)
ROCK SLOPE PROTECTION
GRAVEL BEDDING
VARIES
EXISTING GROUND SURFACE
STRIPPING
COMP RANDOM FILL
SECTION G
ROAD GRAVEL
EL VARIES 148 ± TO 147 ±
TOP SOIL
COMP IMPERVIOUS FILL
COMPACTED PERVIOUS FILL
SEED
EXISTING GROUND SURFACE
STRIPPING
SPOIL FILL
PROCESSED SAND
SUB DRAIN
TOE DRAIN
SECTION C
ROAD GRAVEL - EL VARIES 153 ± TO 150 ±
ROCK SLOPE PROTECTION
GRAVEL BEDDING
EXISTING DIKE
STRIPPING
EXISTING GROUND SURFACE
COMP PERVIOUS FILL
SECTION F
ROCK SLOPE PROTECTION
ROAD GRAVEL - EL VARIES 150 ± TO 148 ±
TOP SOIL
EXISTING STATE DIKE
GRAVEL BEDDING
COMP IMPERVIOUS FILL
SELECTED PERVIOUS FILL
COMPACTED PERVIOUS FILL
SECTION B
ROAD GRAVEL - EL VARIES 167 ± TO 150 ±
VARIES 40' TO 75'
STRIPPING
SECTION D, E & H
MATERIALS SAME AS SECTION "G"
ROCK SLOPE PROTECTION
ROAD GRAVEL - EL VARIES 160 ± TO 151 ±
GRAVEL BEDDING
TOP SOIL
COMP IMPERVIOUS FILL
SPOIL FILL
EXISTING GROUND SURFACE
STRIPPING
COMP PERVIOUS FILL
SUB DRAIN
TOE DRAIN
SELECTED PERVIOUS FILL
SECTION A
NOTE:
FOR LIMITS OF SECTIONS "A" THRU "G" SEE RECOMENDED PLAN
83'-0"
18" Conc. friction piles
RIVER ROAD CONDUIT
SCALE 1" = 10'-0"
39'-6"
10" Conc friction piles
GATED OUTFLOW CONDUITS AT WESTFIELD RIVER
SCALE 1/4" = 1'-0"
42'-0"
19'-0"
BROOK CONDUIT
SCALE 1/4" = 1'-0"
GRAPHIC SCALES
WATER RESOURCES FEASIBILITY REPORT
WESTFIELD LOCAL PROTECTION
PLAN AND TYPICAL SECTIONS
WESTFIELD & LITTLE RIVERS MASSACHUSETTS

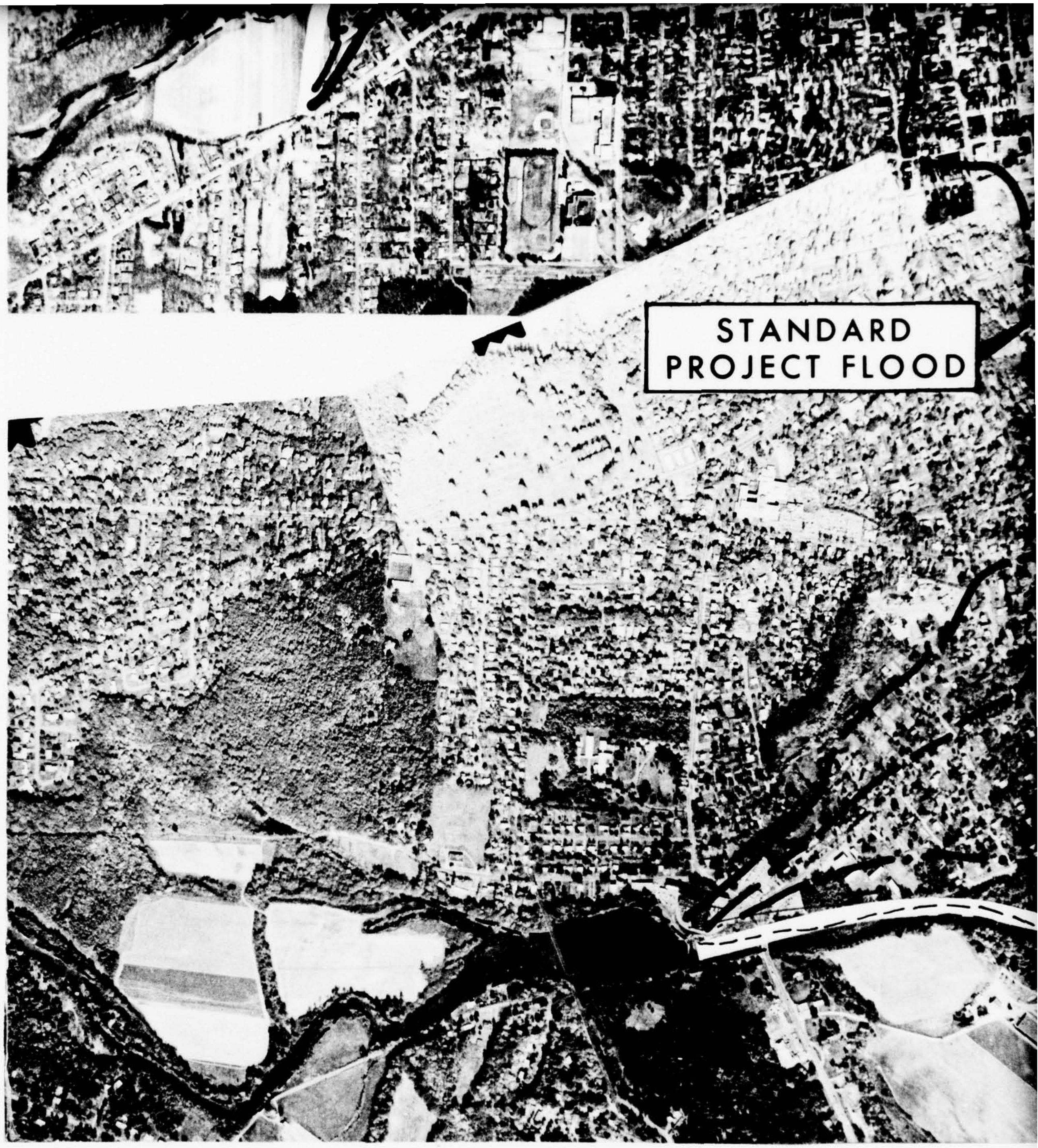

N
WESTFIELD
STANDARD
PROJECT FLOOD



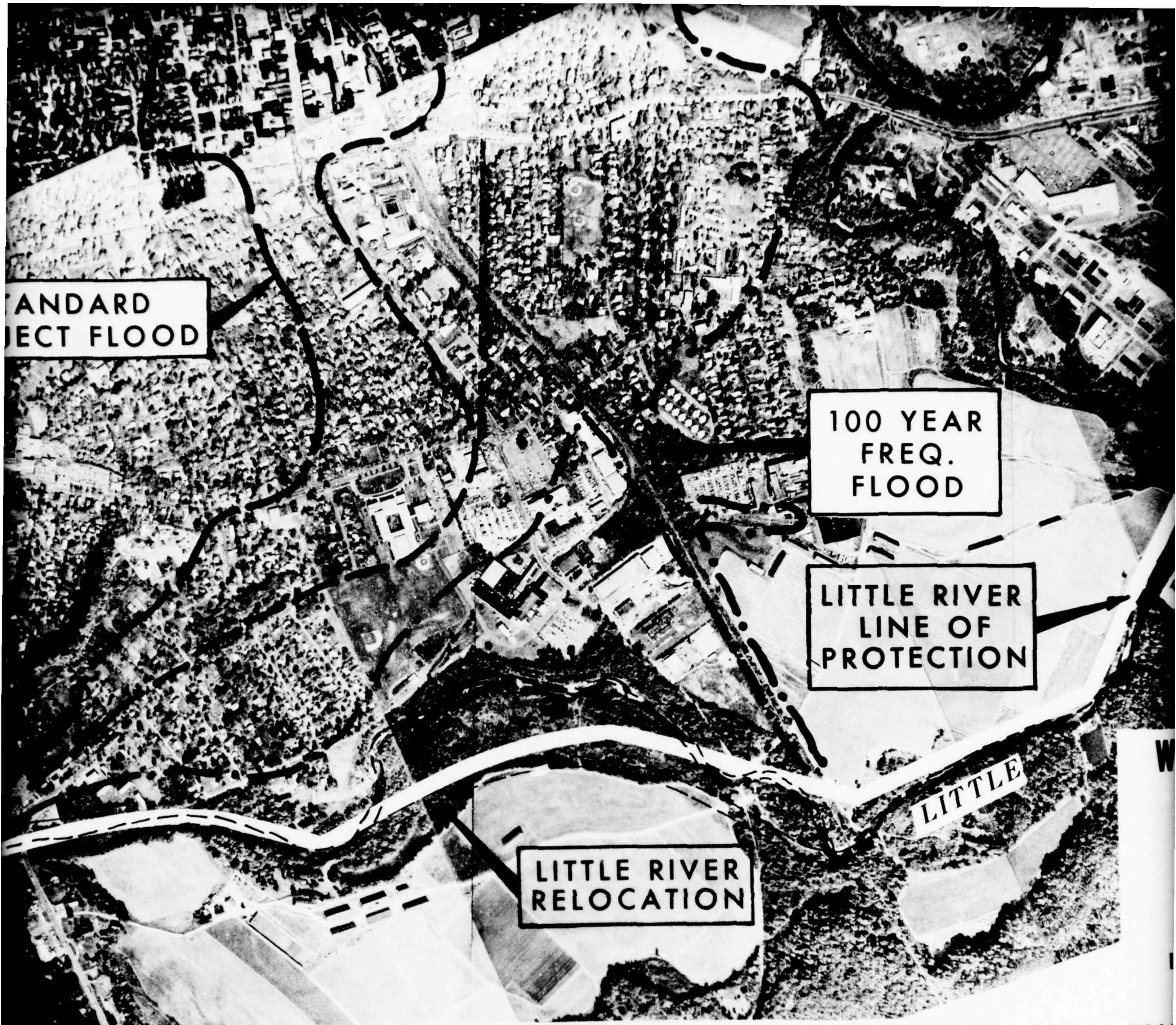
POWDERMILL BROOK LINE OF PROTECTION
POWDER MILL
WESTFIELD RIVER LINE OF PROTECTION
WESTFIELD RIVER RELOCATION
AUG. 1955 FLOOD
RIVER
100 YEAR FREQ. FLOOD

3



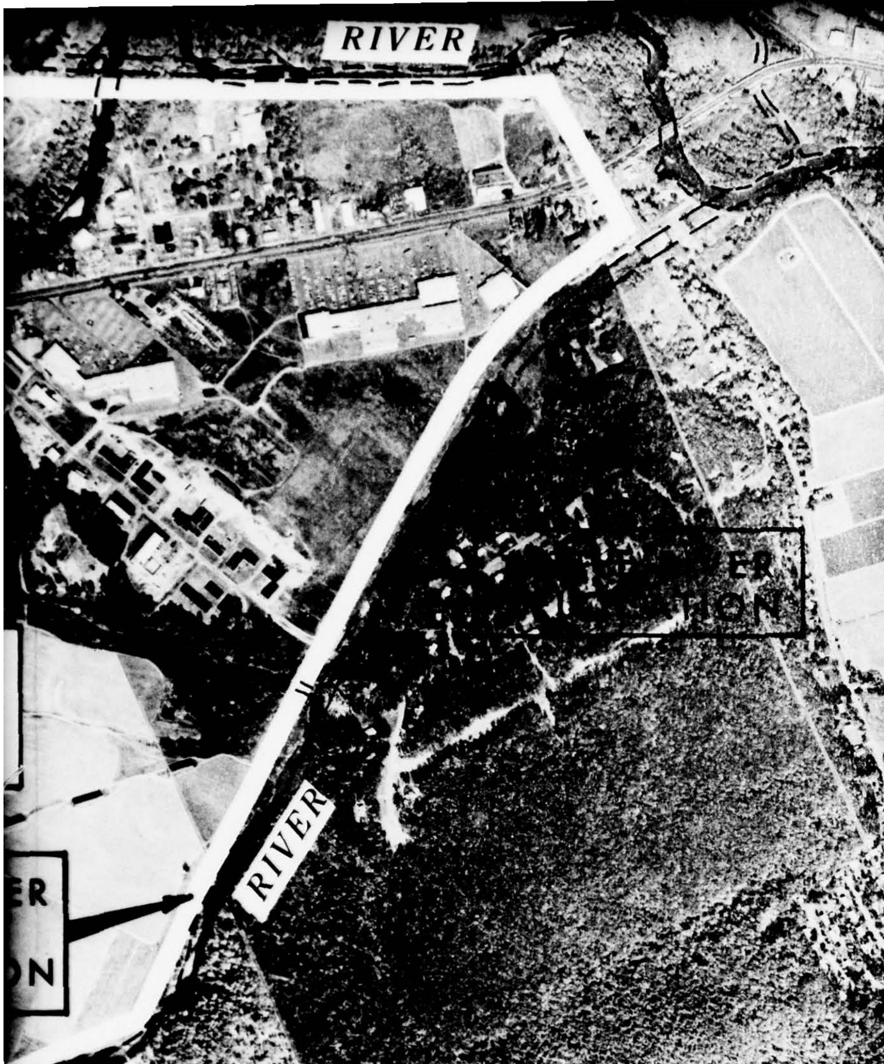



4



TANDARD
JECT FLOOD
100 YEAR
FREQ.
FLOOD
LITTLE RIVER
LINE OF
PROTECTION
LITTLE
LITTLE RIVER
RELOCATION
W
SCA


5




# WESTFIELD LOCAL PROTECTION
# WESTFIELD, LITTLE RIVERS
# AND POWDERMILL BROOK
# GENERAL E.Q. PLAN

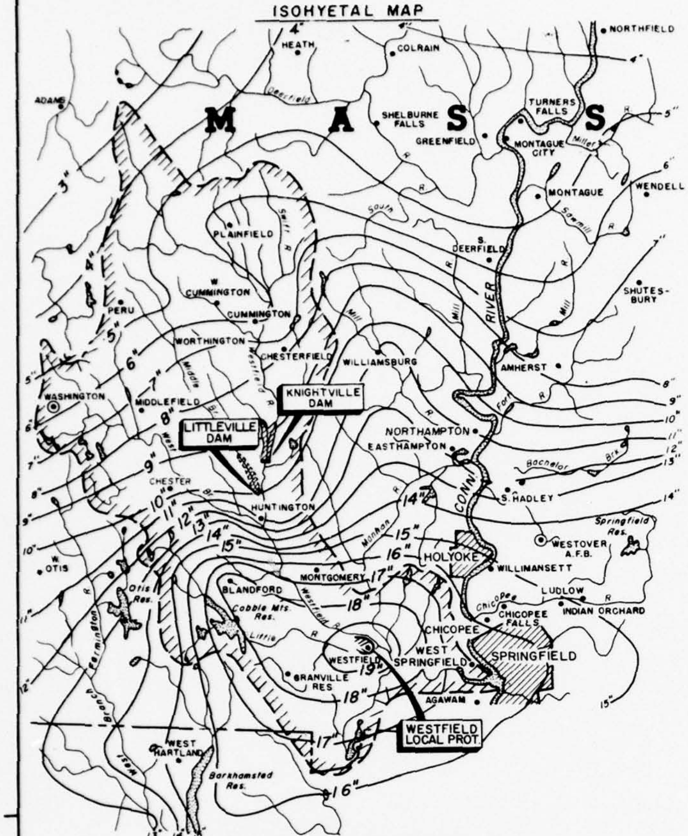
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

SCALE: 1" = 1000' (APPROX.)      PLATE D-5

6

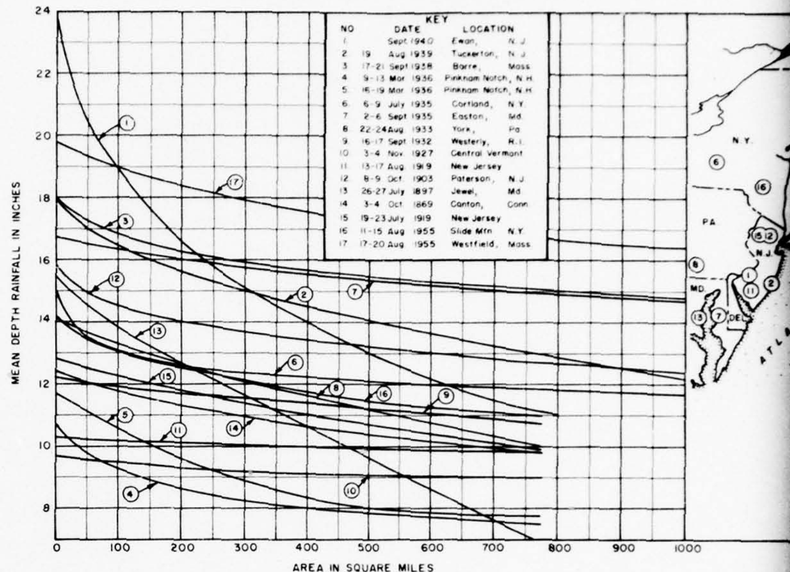
1 CORPS OF ENGINEERS

## ISOHYETAL MAP



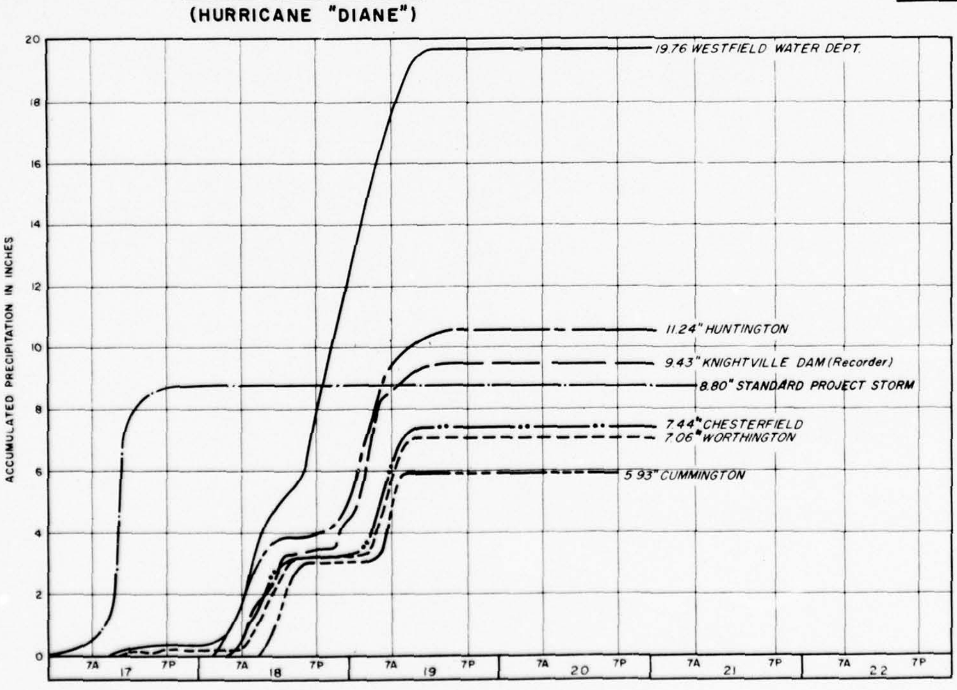

## TOTAL STORM ISOHYETALS
## AUGUST 17-20 1955
## (HURRICANE "DIANE")

## AREA-DEPTH CURVES
## AND LOCATION OF STORM CENTERS

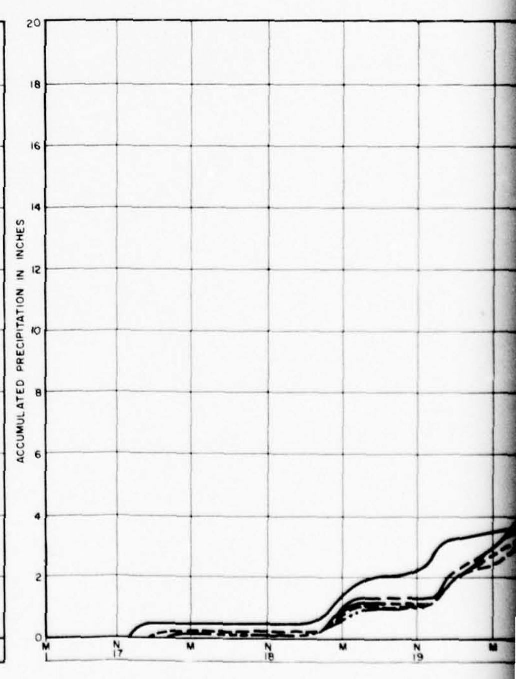



## STORMS OF RECORD
## NORTHEASTERN UNITED STATES

## MASS CURVES



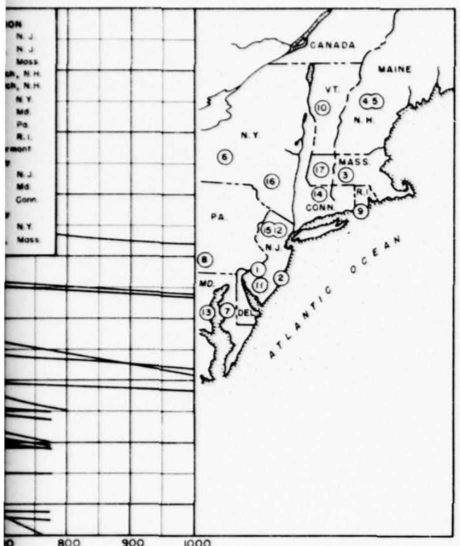

AUGUST 1955




SEPTEMBE

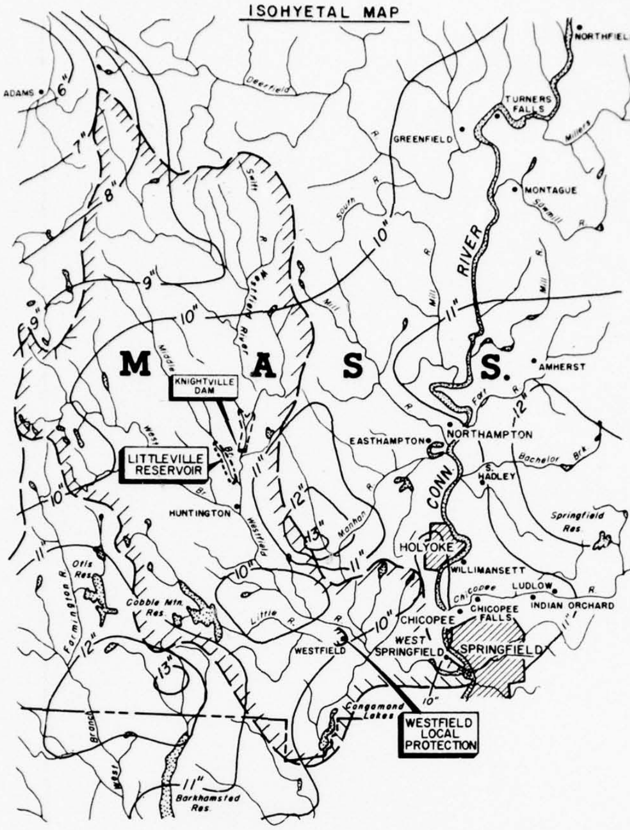
U.S. ARMY

...TH CURVES
...T STORM CENTERS

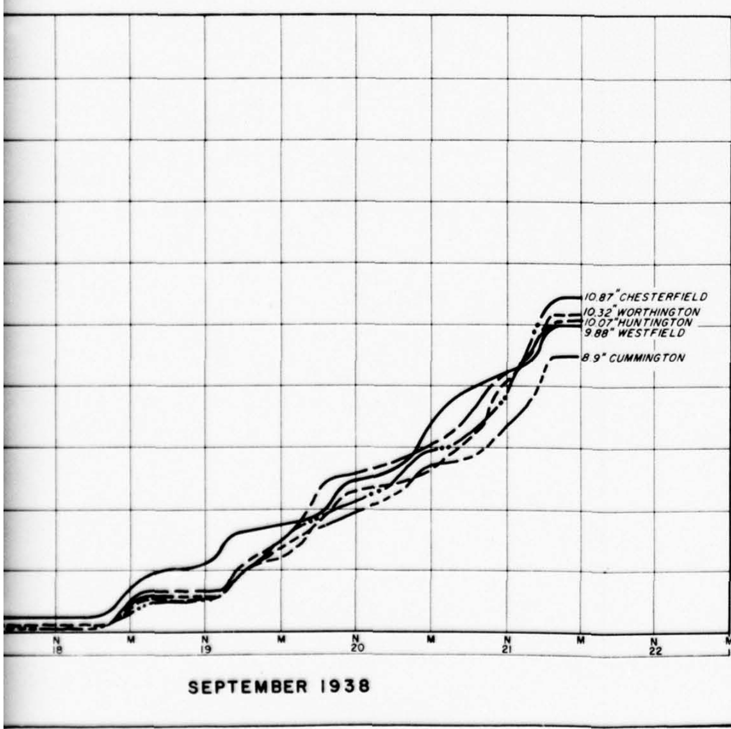



...OF RECORD
... UNITED STATES

ISOHYETAL MAP




TOTAL STORM ISOHYETALS
SEPTEMBER 17-22, 1938




SEPTEMBER 1938

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
WALTHAM, MASS.

| DR. BY | TR. BY S.J.C. | CK. BY E.P.S. |
|---|---|---|

SUBMITTED

PROJECT ENGINEER

APPROVAL RECOMMENDED

CHIEF, HYD. & HYD. SECTION

APPROVAL RECOMMENDED

CHIEF P. & R. BRANCH

CONNECTICUT RIVER FLOOD CONTROL

**WESTFIELD LOCAL PROTECTION**

**HYDROLOGIC DATA FOR RECORD STORMS**

**WESTFIELD & LITTLE RIVERS MASS.**

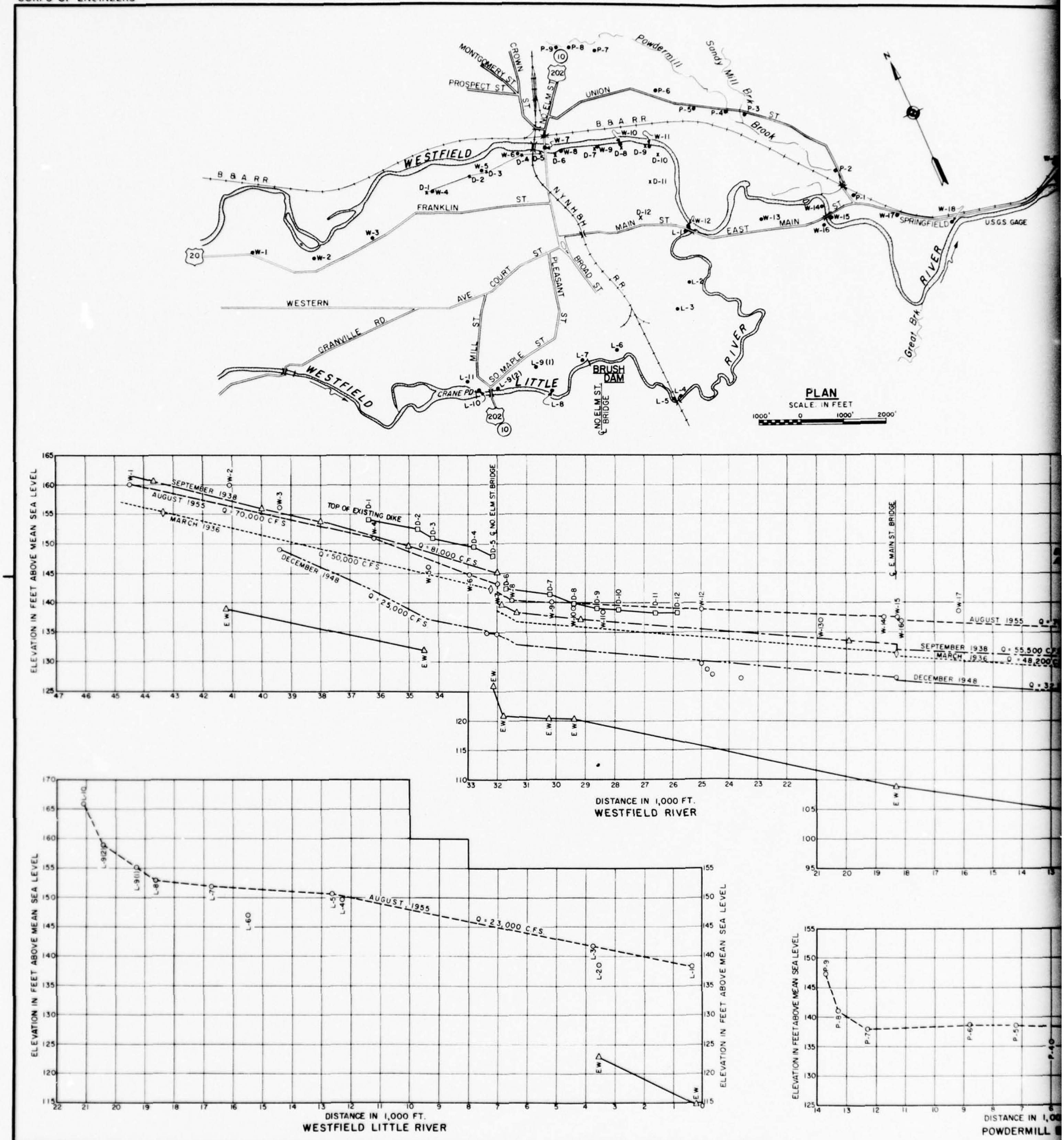
APPROVED DATE OCTOBER 1963

CHIEF ENGINEERING DIVISION

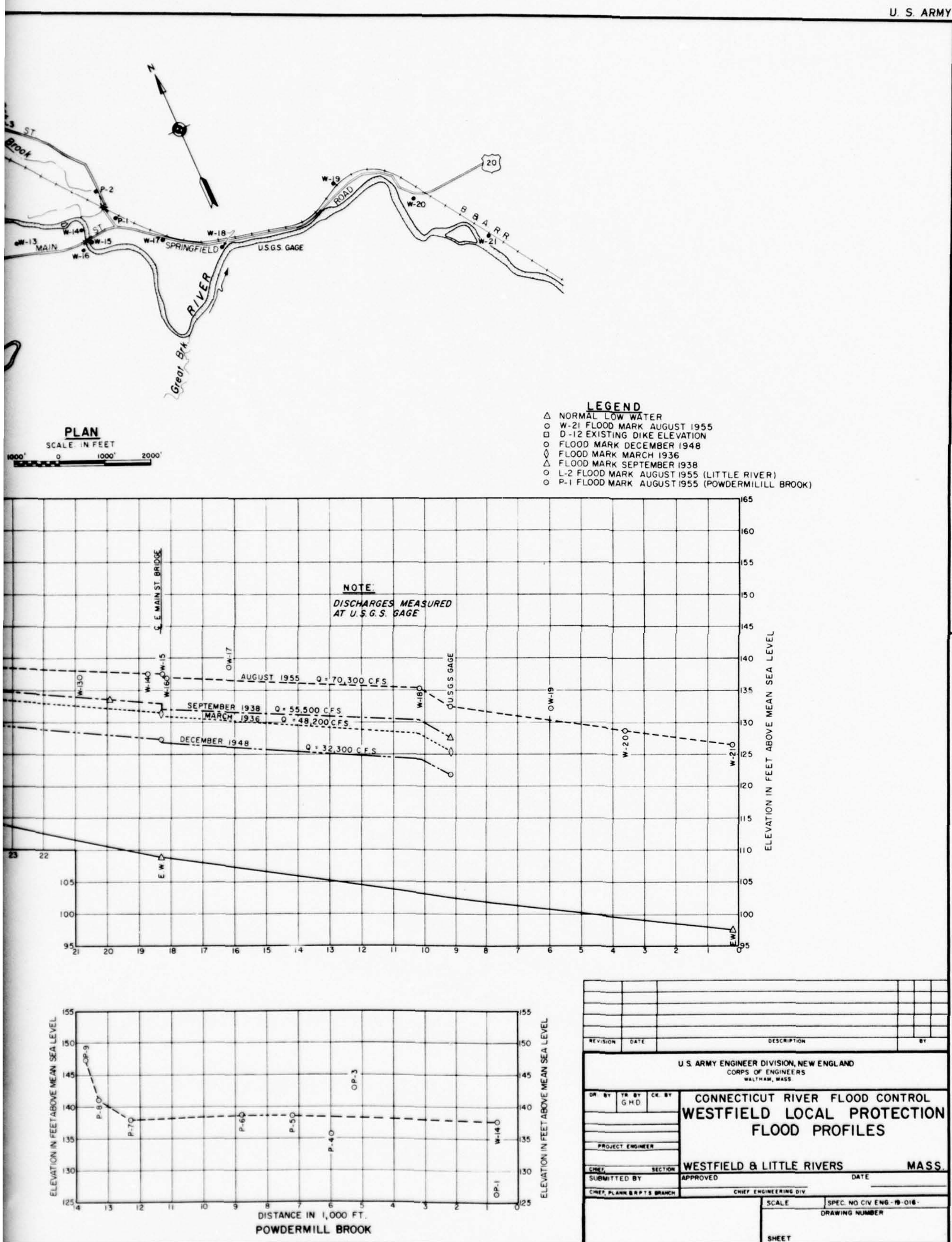
SCALE AS NOTED.

DRAWING NUMBER
CT-1-4571

SHEET 1 OF 1

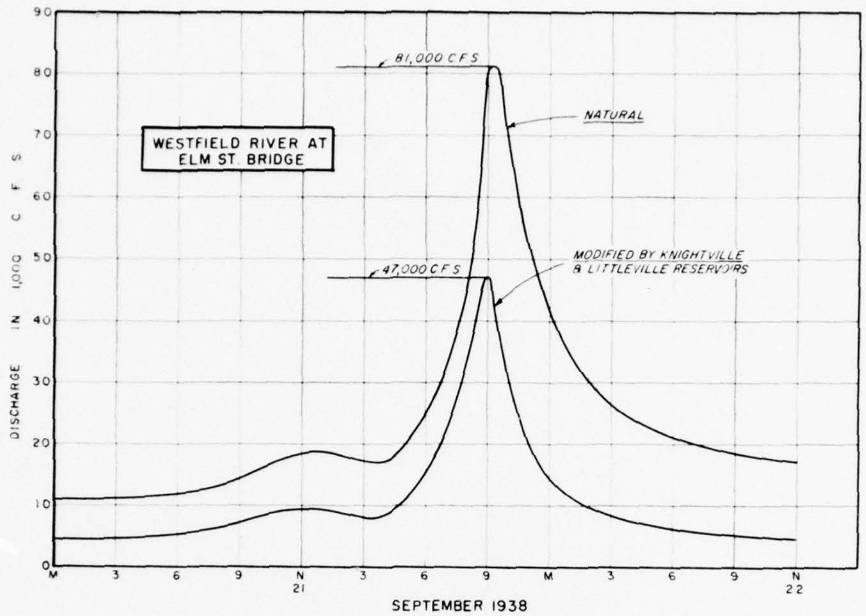

PLAN
SCALE IN FEET
1000' 0 1000' 2000'
WESTFIELD
RIVER
WESTFIELD LITTLE RIVER
Powdermill Brook
Sandy Mill Brk
Great Brk
B. & A. RR.
N.Y.N.H.& H. R.R.
MONTGOMERY ST
CROWN ST
PROSPECT ST
N. ELM ST
UNION ST
FRANKLIN ST.
MAIN ST.
EAST MAIN ST.
SPRINGFIELD
USGS GAGE
BROAD ST
COURT ST
PLEASANT ST
WESTERN AVE
GRANVILLE RD
MILL ST
SO MAPLE ST
CRANE PD
BRUSH DAM
℄ NO. ELM ST BRIDGE
TOP OF EXISTING DIKE
SEPTEMBER 1938
AUGUST 1955
MARCH 1936
DECEMBER 1948
Q = 70,000 C.F.S.
Q = 81,000 C.F.S.
Q = 50,000 C.F.S.
Q = 25,000 C.F.S.
Q = 55,500 C.F.S.
Q = 48,200 C.F.S.
Q = 23,000 C.F.S.
℄ NO. ELM ST BRIDGE
℄ E. MAIN ST BRIDGE
E.W.
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
DISTANCE IN 1,000 FT.
WESTFIELD RIVER
DISTANCE IN 1,000 FT.
WESTFIELD LITTLE RIVER
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
DISTANCE IN 1,00
POWDERMILL

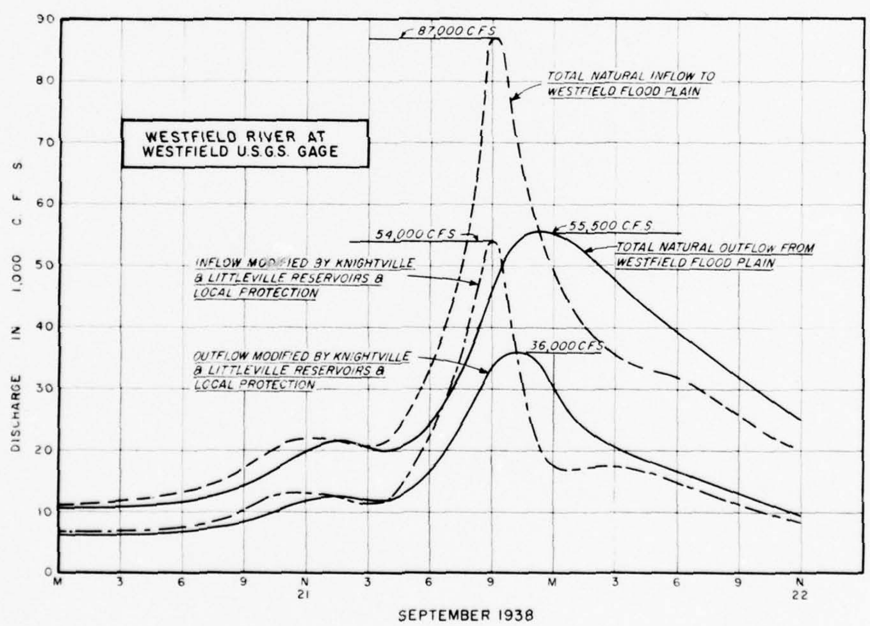
2



U. S. ARMY
N
20
ST
Brook
P-2
P-1
W-13
W-14
W-15
W-16
MAIN
ST
W-17
SPRINGFIELD
W-18
U.S.G.S. GAGE
W-19
ROAD
W-20
B & A R R
W-21
RIVER
Great Brk.
PLAN
SCALE: IN FEET
1000' 0 1000' 2000'
LEGEND
NORMAL LOW WATER
W-21 FLOOD MARK AUGUST 1955
D-12 EXISTING DIKE ELEVATION
FLOOD MARK DECEMBER 1948
FLOOD MARK MARCH 1936
FLOOD MARK SEPTEMBER 1938
L-2 FLOOD MARK AUGUST 1955 (LITTLE RIVER)
P-1 FLOOD MARK AUGUST 1955 (POWDERMILILL BROOK)
NOTE:
DISCHARGES MEASURED AT U.S.G.S. GAGE
C. E. MAIN ST. BRIDGE
AUGUST 1955 Q = 70,300 C.F.S.
SEPTEMBER 1938 Q = 55,500 C.F.S.
MARCH 1936 Q = 48,200 C.F.S.
DECEMBER 1948 Q = 32,300 C.F.S.
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
DISTANCE IN 1,000 FT.
POWDERMILL BROOK
REVISION DATE DESCRIPTION BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
TR. BY G.H.D.
CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD LOCAL PROTECTION
FLOOD PROFILES
WESTFIELD & LITTLE RIVERS MASS.
PROJECT ENGINEER
SUBMITTED BY
APPROVED
DATE
CHIEF, ENGINEERING DIV.
SCALE
SPEC. NO. CIV. ENG.-19-016-
DRAWING NUMBER
SHEET


PLATE D-7




U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY G.H.D. | CK. BY

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANN & RPTS BRANCH

CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD LOCAL PROTECTION
SEPTEMBER 1938 FLOOD
NATURAL & MODIFIED HYDROGRAPHS
WESTFIELD & LITTLE RIVERS, MASS.

APPROVED

CHIEF, ENGINEERING DIV.

DATE OCTOBER 1963

SCALE

SPEC. NO. CIV. ENG. -19-016-

DRAWING NUMBER

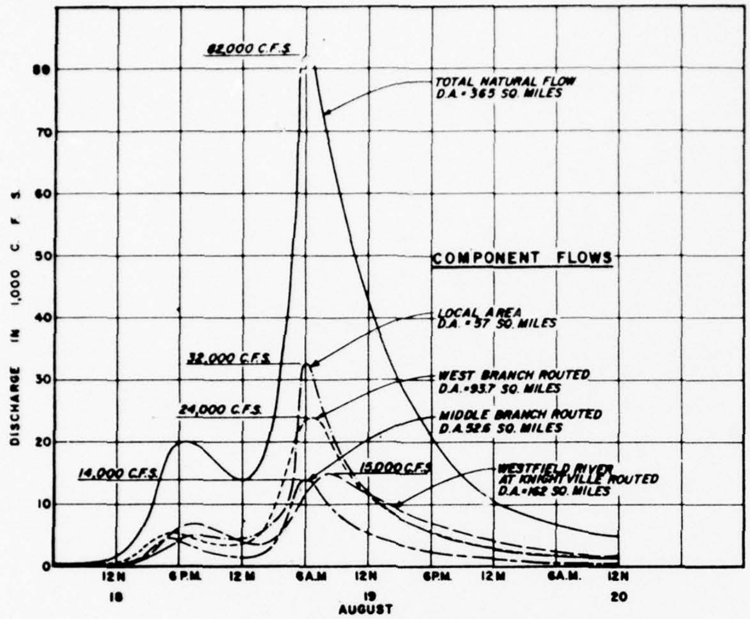
SHEET

PLATE D-8

CORPS OF ENGINEERS

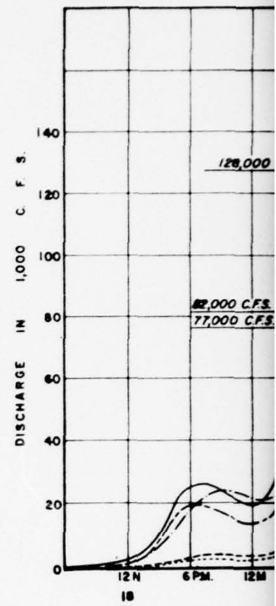
## AUGUST 1955 FLOOD

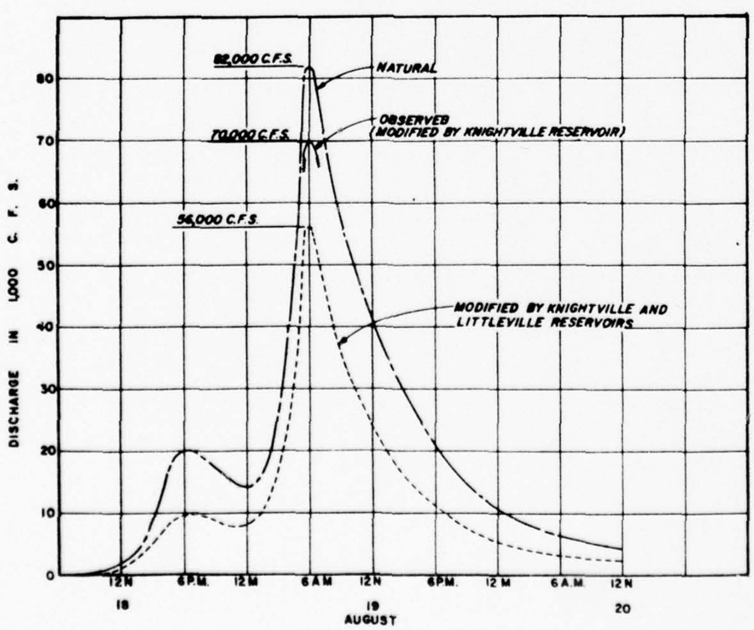
### ELM STREET BRIDGE



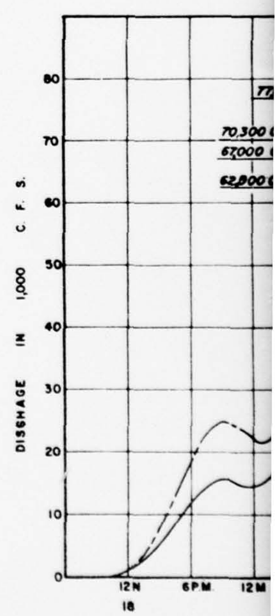

NATURAL

### WESTFIE



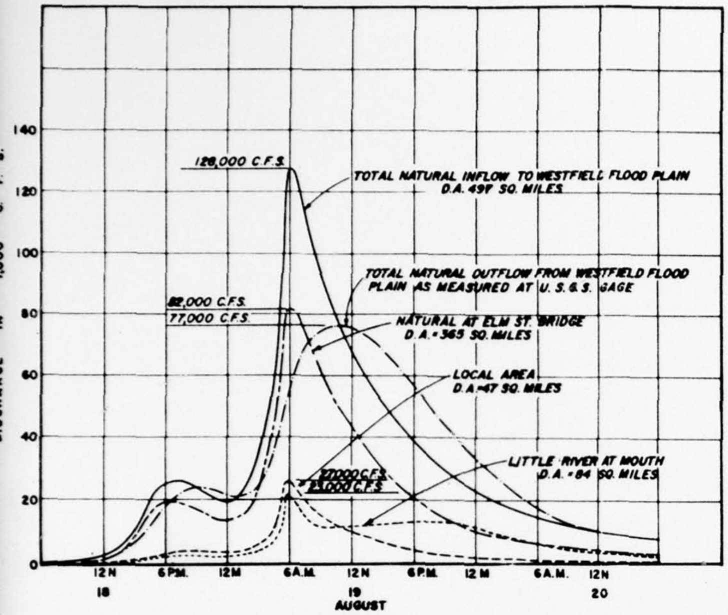

MODIFIED



2



WESTFIELD U.S.G.S. GAGE

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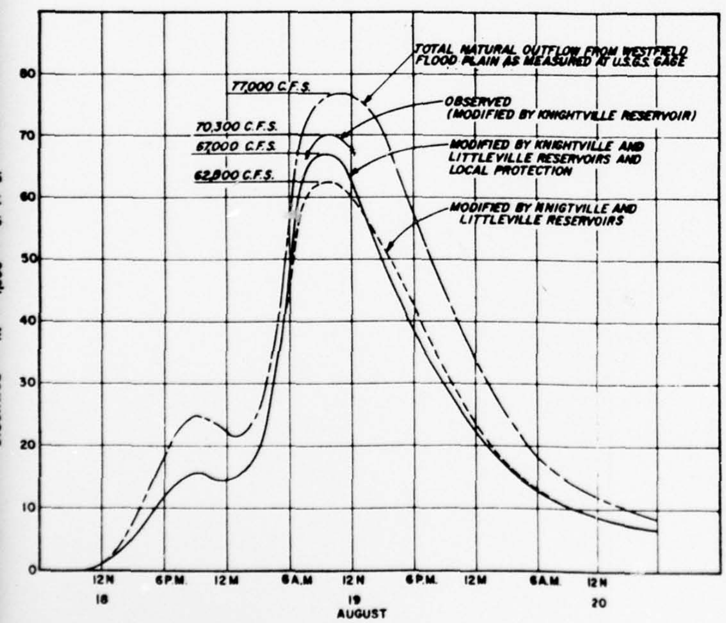



MODIFIED

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER FLOOD CONTROL

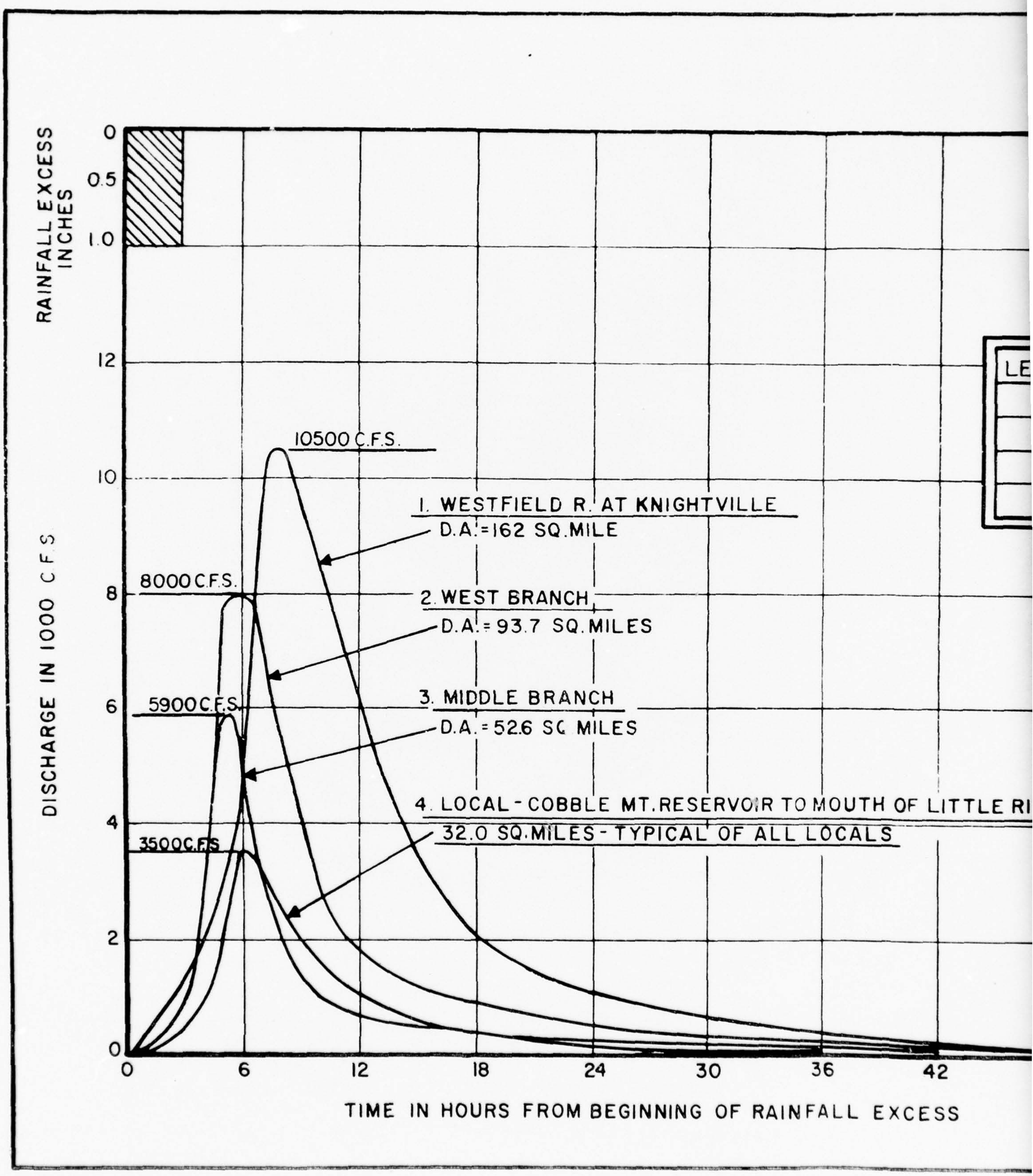
**WESTFIELD LOCAL PROTECTION**

AUGUST 1955 FLOOD

NATURAL AND MODIFIED HYDROGRAPHS

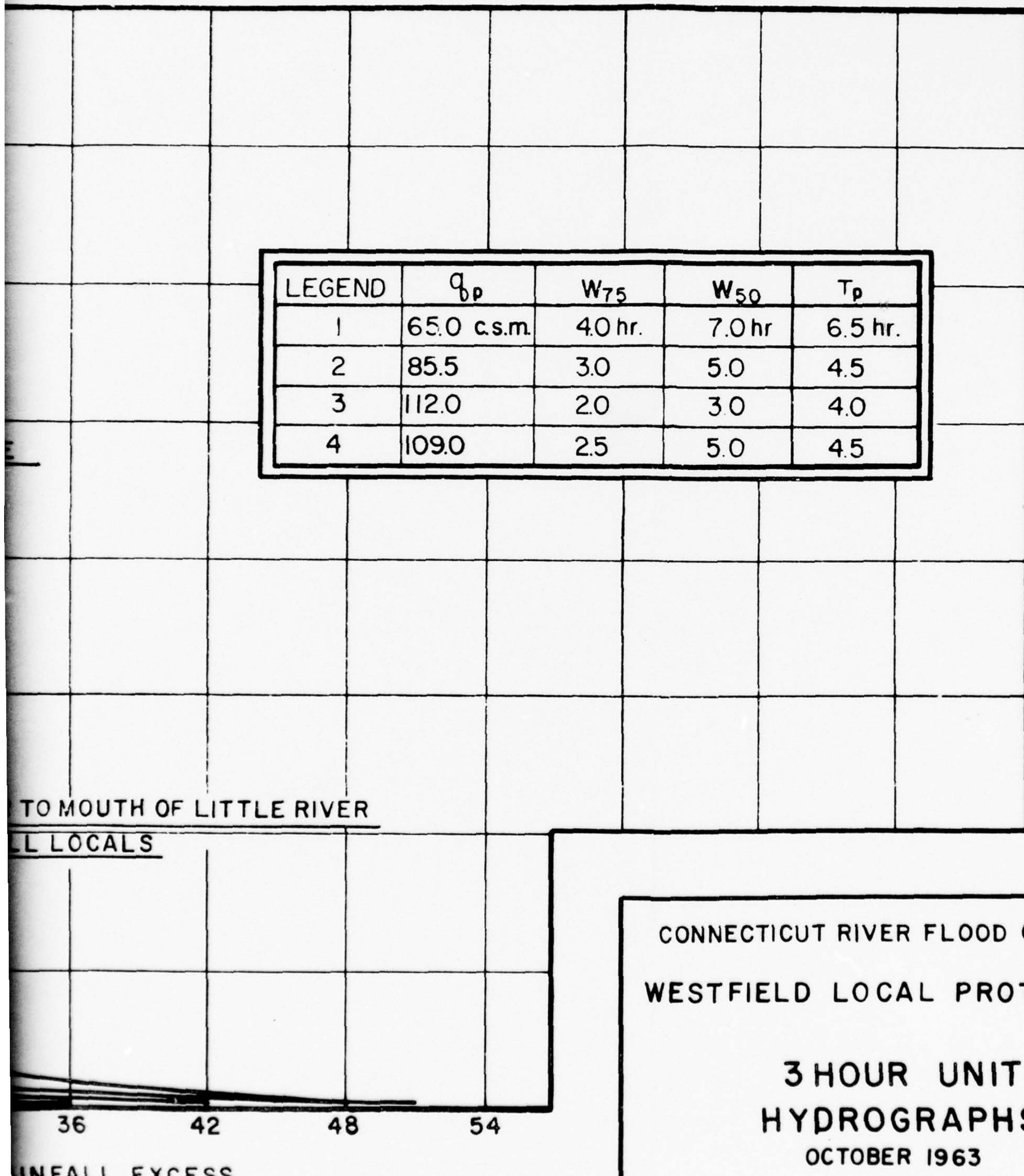
WESTFIELD & LITTLE RIVERS MASS.

DATE OCTOBER 1963



RAINFALL EXCESS INCHES
0
0.5
1.0
DISCHARGE IN 1000 C.F.S.
12
10
8
6
4
2
0
10500 C.F.S.
8000 C.F.S.
5900 C.F.S.
3500 C.F.S.
1. WESTFIELD R. AT KNIGHTVILLE
D.A.=162 SQ.MILE
2. WEST BRANCH
D.A.=93.7 SQ.MILES
3. MIDDLE BRANCH
D.A.=52.6 SQ MILES
4. LOCAL - COBBLE MT. RESERVOIR TO MOUTH OF LITTLE RI
32.0 SQ.MILES - TYPICAL OF ALL LOCALS
0
6
12
18
24
30
36
42
TIME IN HOURS FROM BEGINNING OF RAINFALL EXCESS
LE

2




| LEGEND | $q_p$ | $W_{75}$ | $W_{50}$ | $T_p$ |
|---|---|---|---|---|
| 1 | 65.0 c.s.m. | 4.0 hr. | 7.0 hr | 6.5 hr. |
| 2 | 85.5 | 3.0 | 5.0 | 4.5 |
| 3 | 112.0 | 2.0 | 3.0 | 4.0 |
| 4 | 109.0 | 2.5 | 5.0 | 4.5 |

CONNECTICUT RIVER FLOOD CONTROL

WESTFIELD LOCAL PROTECTION

## 3 HOUR UNIT HYDROGRAPHS

OCTOBER 1963

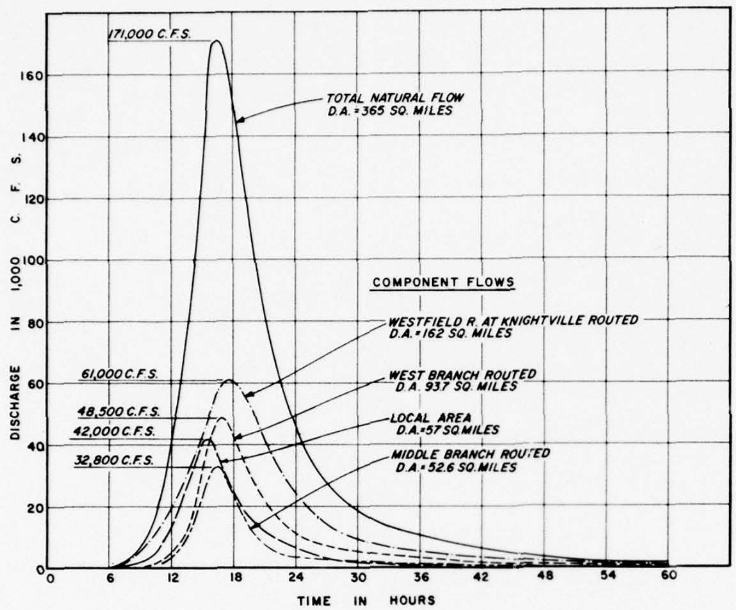
WESTFIELD & LITTLE RIVERS MASS

PLATE D-10

CORPS OF ENGINEERS

# STANDARD PROJECT FLOOD

## ELM STREET BRIDGE

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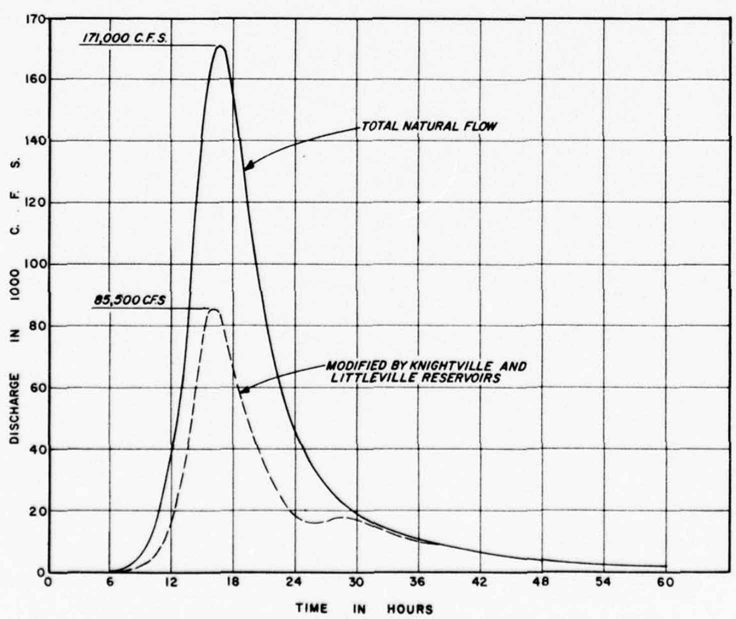


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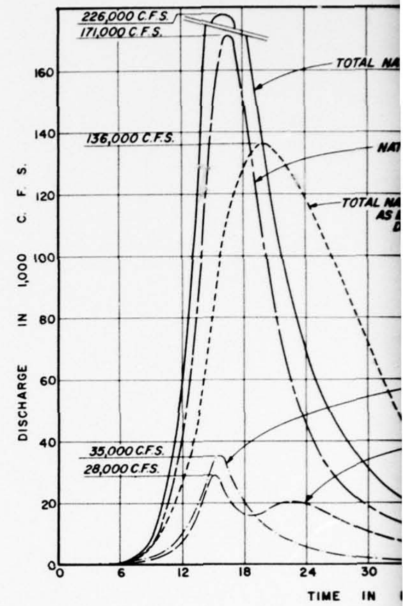


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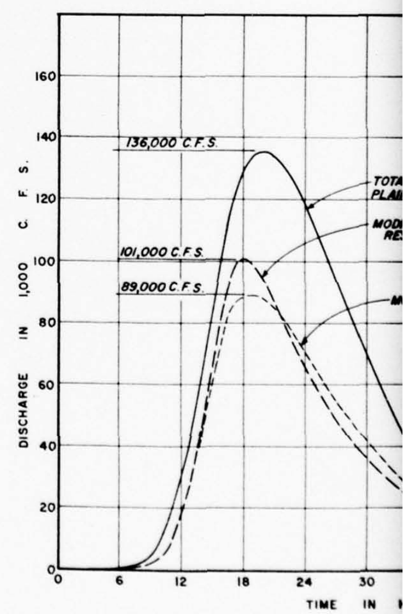


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U. S. ARMY

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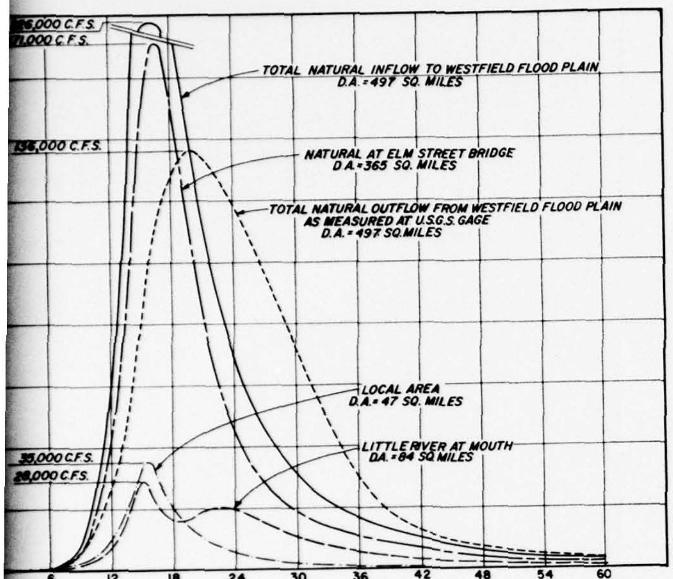
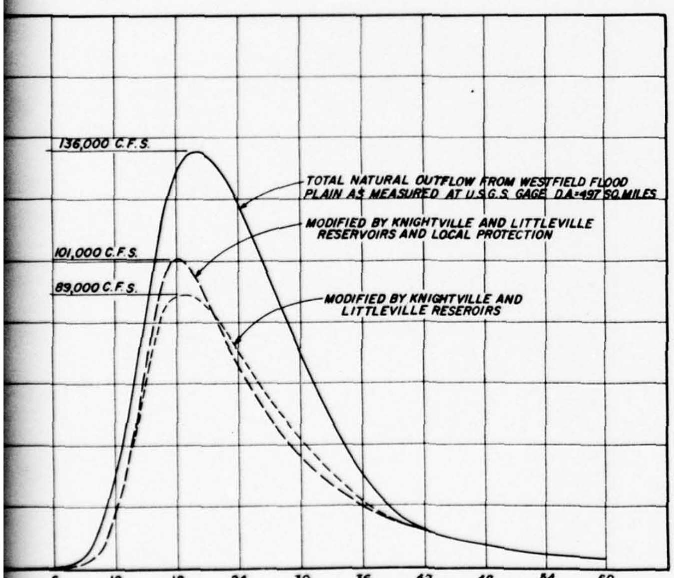
**WESTFIELD U.S.G.S. GAGE**




TIME IN HOURS

**NATURAL**




TIME IN HOURS

**MODIFIED**

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY | CK. BY

CONNECTICUT RIVER FLOOD CONTROL

**WESTFIELD LOCAL PROTECTION**

**STANDARD PROJECT FLOOD**
**NATURAL AND MODIFIED HYDROGRAPHS**

WESTFIELD & LITTLE RIVERS MASS.

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANN. & RPTS BRANCH

APPROVED

CHIEF ENGINEERING DIV.

DATE OCTOBER 1963

SCALE

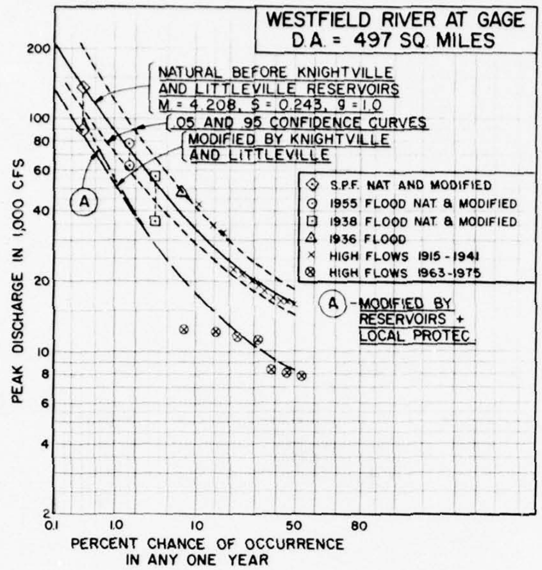
SPEC. NO. CIV ENG-19-016-

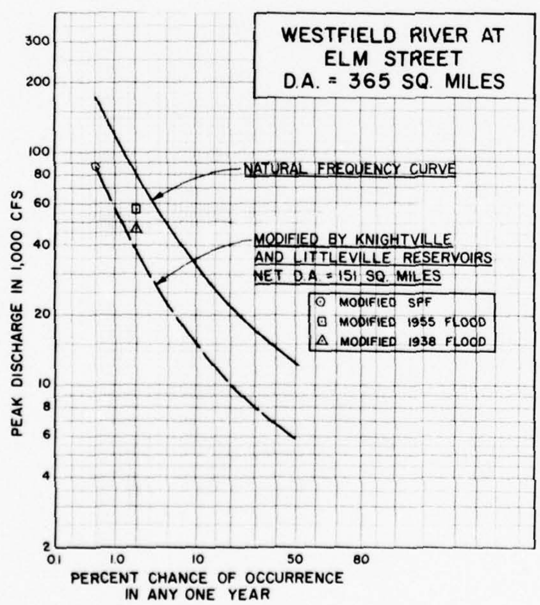
DRAWING NUMBER

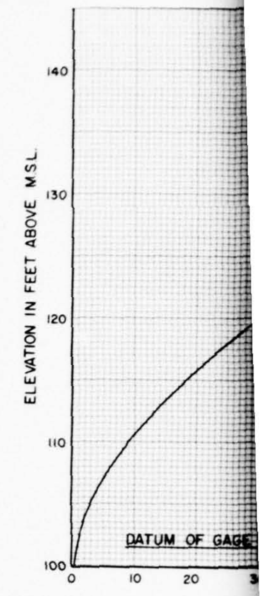
SHEET

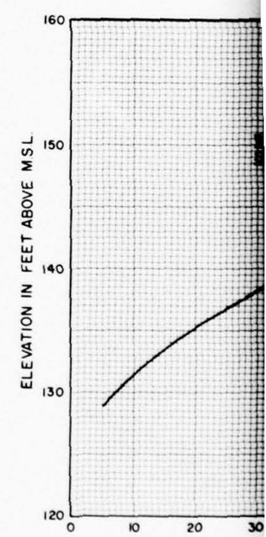
PLATE D-11

CORPS OF ENGINEERS

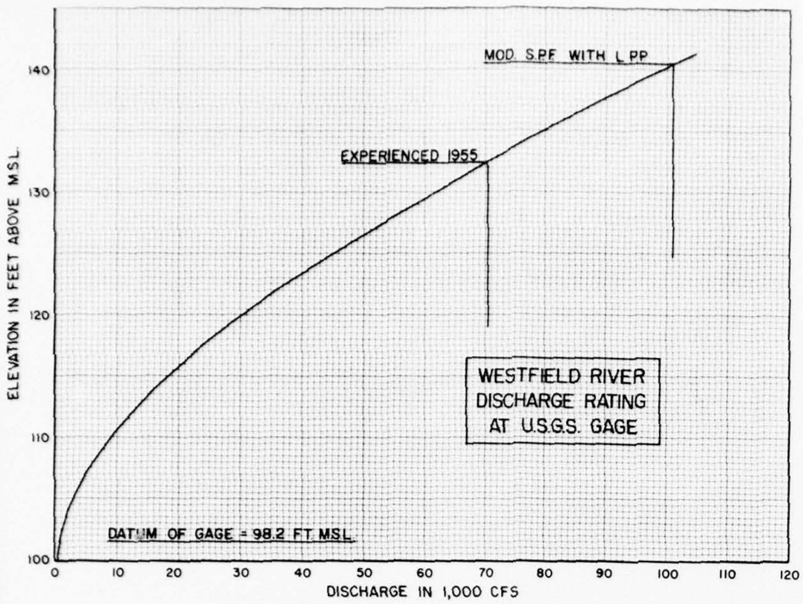


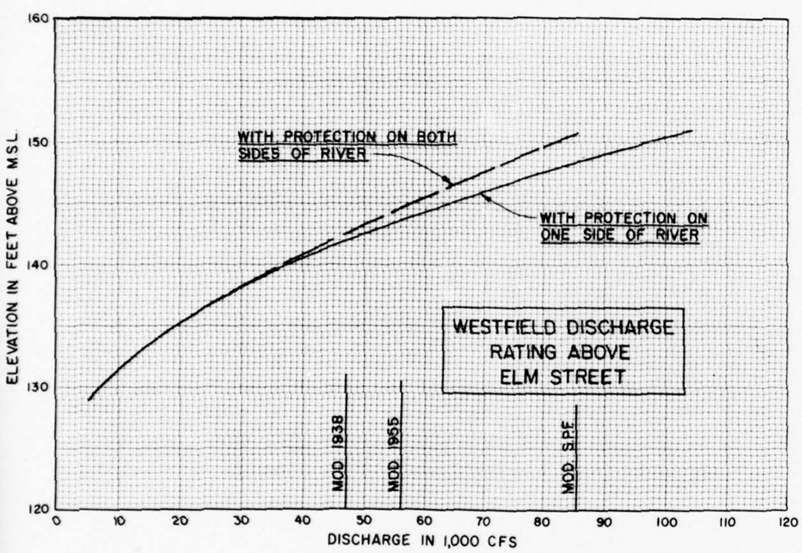



U. S. ARMY




GRAPHIC SCALES

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

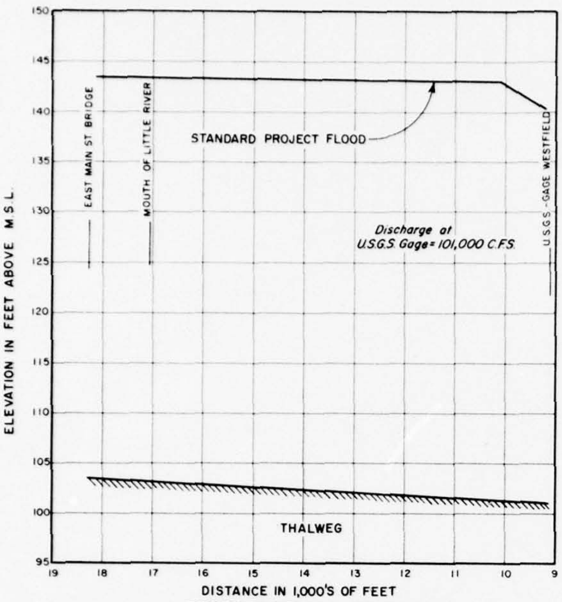
CONNECTICUT RIVER FLOOD CONTROL

DISCHARGE FREQUENCIES & RATING CURVES
WESTFIELD RIVER AT WESTFIELD, MASS.

DES. BY / DR. BY / CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

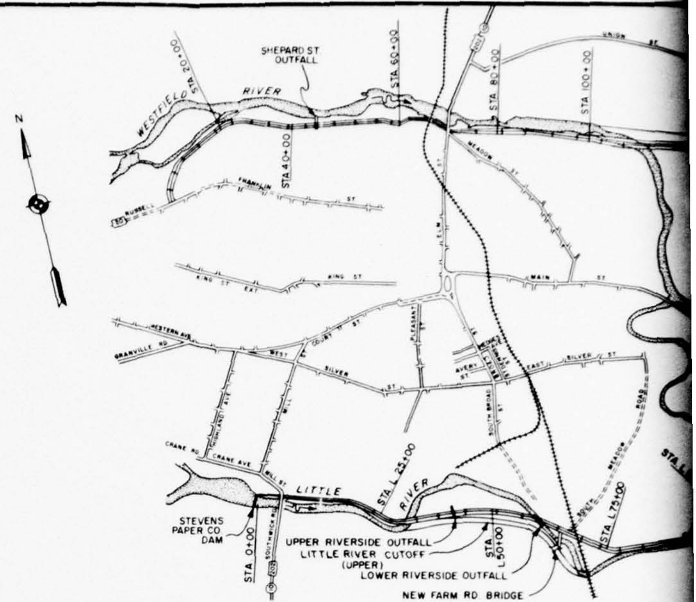
APPROVED
CHIEF, ENGINEERING DIVISION
DATE MAY 1978
SCALE
SPEC. NO.
DRAWING NUMBER
SHEET

PLATE D-12



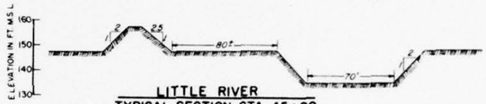

WESTFIELD RIVER

U.S.G.S. GAGE TO EAST MAIN ST. BRIDGE



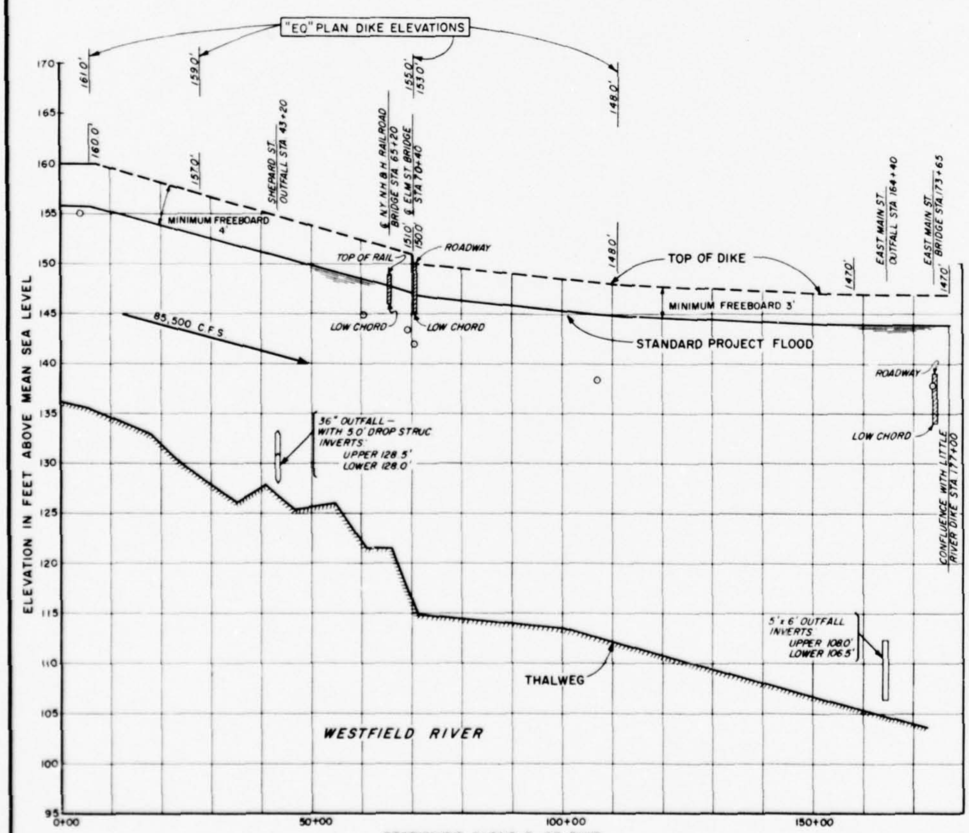

WESTFIELD MASS.

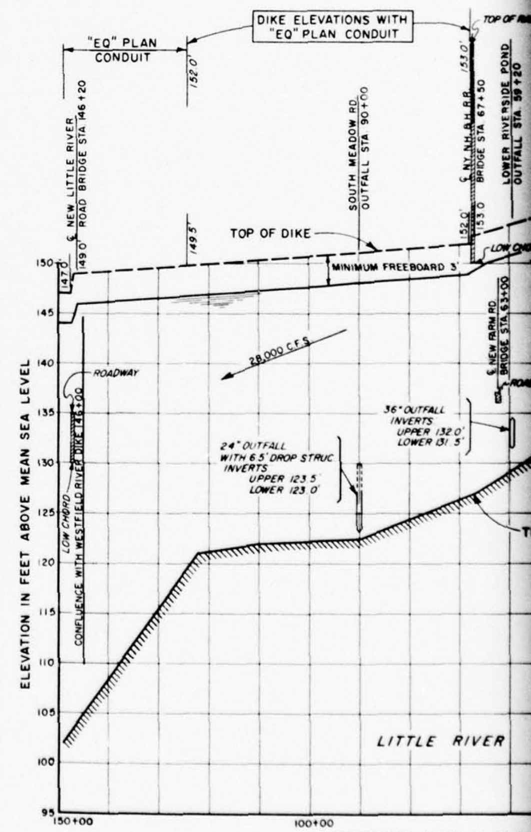
LOCAL PROTECTION PROJ




LITTLE RIVER

TYPICAL SECTION STA 45+00

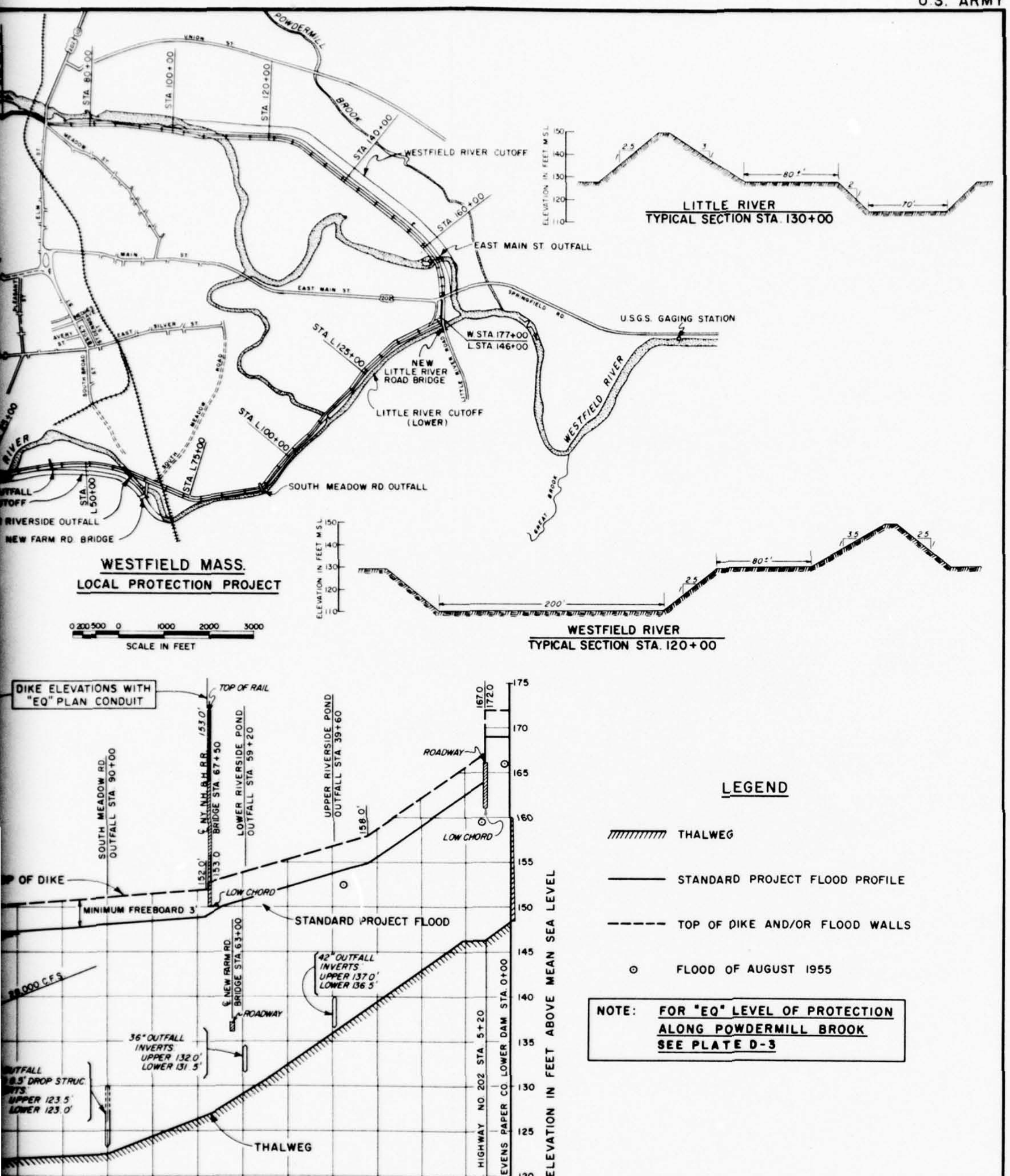



WESTFIELD AND LITTLE RIVER PROFILES

2

U.S. ARMY




## LEGEND

- THALWEG
- STANDARD PROJECT FLOOD PROFILE
- TOP OF DIKE AND/OR FLOOD WALLS
- FLOOD OF AUGUST 1955

NOTE: FOR "EQ" LEVEL OF PROTECTION ALONG POWDERMILL BROOK SEE PLATE D-3

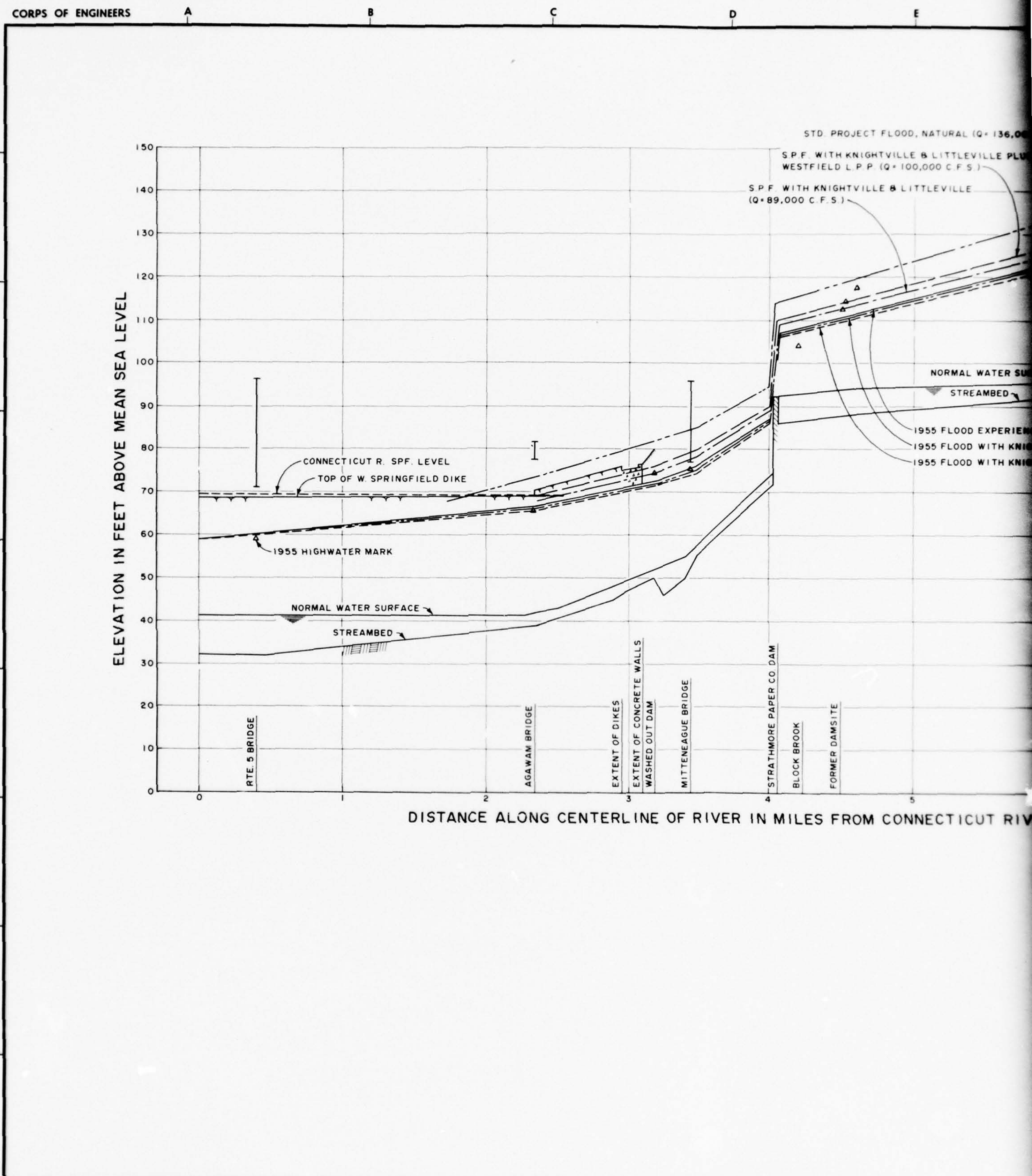
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

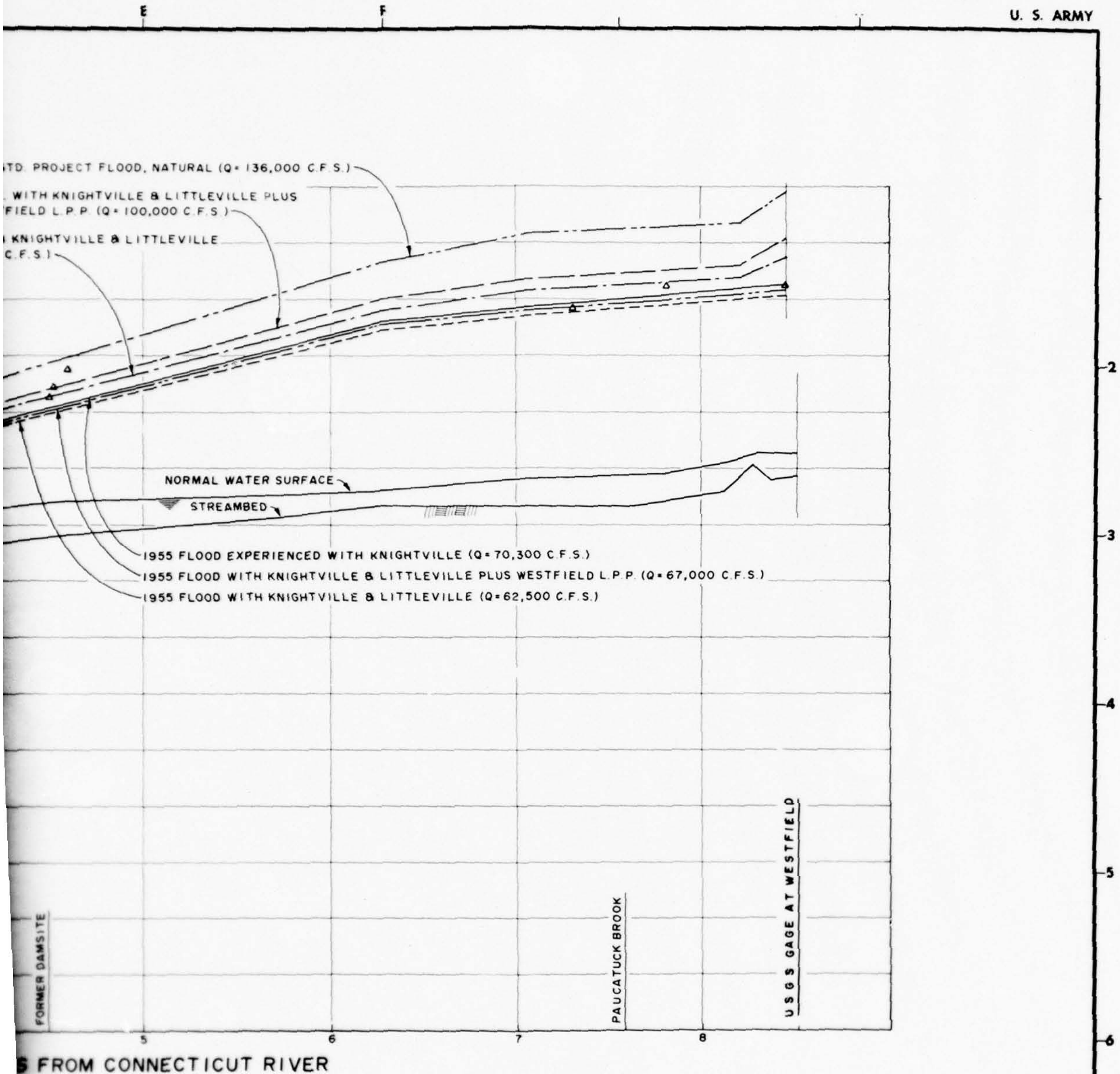
CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD LOCAL PROTECTION
"NED" PLAN AND PROFILES
WESTFIELD & LITTLE RIVERS MASS.

DR. BY | TR. BY G.H.D. | CK. BY
PROJECT ENGINEER
CHIEF BRANCH
SUBMITTED BY | APPROVED | DATE OCTOBER 1963
CHIEF, PLANN. & RPTS BRANCH | CHIEF, ENGINEERING DIVISION
SCALE: AS SHOWN
DRAWING NUMBER
SHEET 1 OF 1

PLATE D-13

CORPS OF ENGINEERS






GRAPHIC SCALES

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

CONNECTICUT RIVER FLOOD CONTROL

COMPUTED WESTFIELD RIVER PROFILES

DOWNSTREAM OF GAGE AT WESTFIELD, MASS.

APPROVED
CHIEF, ENGINEERING DIVISION
DATE MAY 1978

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE D-14

# SECTION E

## FORMULATING A PLAN

SECTION E

# *FORMULATING A PLAN*

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# SECTION E

# FORMULATING A PLAN

Plan formulation is the process of developing and evaluating alternative plans to meet the needs and desires of the study area.

The principal water resource need within the city of Westfield is the need for flood management measures. An associated concern, but a problem of a lesser magnitude, is the need to prevent the degradation of water quality that could result from flooding or might be associated with various flood management measures. Alternative plans also were formulated to meet the objectives of National Economic Development (NED), and Environmental Quality (EQ).

The iterative formulation process has resulted in a determination that a local flood protection project is the optimum type of flood protection for the city of Westfield, and that associated concerns of water quality, recreation, and fish and wildlife resources can be satisfied. This report will address those flood management measures which could be combined to provide the optimum water resources plan for local flood control and associated purposes.

## FORMULATION AND EVALUATION CRITERIA

Plans for improvements of the area, in the context of the two objectives, (NED and EQ) were prepared and evaluated on the basis of appropriate technical engineering. When the flood management problem of the area was essentially solved, each plan was evaluated for its costs, its effects on economic development, and the social impacts, in accordance with the Principles and Standards for Water Resources Planning and Related Resources. On the basis of the final comparisons, local interest selected a plan they judged most suitable for the area.

## WITHOUT PROJECT PROTECTION

In order to properly evaluate the impacts of proposed project alternatives, it is essential to understand those impacts which would

result if no action is taken. The primary objective of this study is to prevent flood damage in the city of Westfield.

Plate C-2 of this appendix indicates the limits of flooding of the project design flood (Standard Project Flood) within the study area. Without a project, flooding and the resulting damages would continue to occur. The following paragraphs describe the economic, human and environmental consequences which can be anticipated if no flood protection is provided.

ECONOMIC IMPACTS

The primary consequences of no action would be the continued economic loss and danger to human life from flooding. Property values within the flood prone area, with no action, will be relatively lower due to threat of flooding. This would result in a lower resale value to the property owner than a like piece of property which would not be subject to flooding, and a lower tax revenue for the city of Westfield. More details of the economic consequences of no action are contained in Section C of this Appendix where flood damages under existing and future conditions are described.

HUMAN IMPACTS

Without a project, flooding will continue to cause obstruction to pedestrian or vehicular traffic and the danger of not being able to obtain necessary food, shelter, and emergency services.

ENVIRONMENTAL IMPACTS

Without a project, the rivers will be left in their present state. Periodic flooding will destroy some fish, animal and plant life.

FLOOD PLAIN MANAGEMENT MEASURES

Potential measures to manage the flood problem without structural measures include flood plain zoning, building code regulations, flood proofing of individual buildings, permanent evacuation of flood plain areas, wetlands regulation, flood insurance and conservation restrictions. The above measures will in general slow down the construction activities in the flood prone area, increase their cost, and in some cases eliminate from business use some of the otherwise most desirable land.

## POSSIBLE SOLUTIONS

Alternative measures to alleviate flooding problems can be divided into two broad categories, nonstructual and structural measures.

Nonstructural measures include flood plain zoning, building code regulations, floodproofing of individual buildings, permanent evacuation of flood plain area, wetland regulation and conservation restrictions. Structural measures include storage reservoirs, channel improvements, levees, diversions, and relief conduits, separately or in combination.

## NONSTRUCTURAL MEASURES

Nonstructural measures do not necessarily reduce or eliminate flooding, but rather attempt to regulate the use and development of the flood plain, thus lessening the damaging effects of all floods. See Section I of this Appendix for an in-depth description of nonstructural solutions.

Ordinarily, land acquisition in the flood plain could be used to restrict land uses to those which would experience little or no flood damage, and upstream of the flood plain, acquired land could be retained for use as flow retarding wetlands. However, acquisition of land in the Westfield flood plain would be too costly, and acquisition of land upstream for natural flood storage would not be effective due to the rapid runoff characteristics of the river basin. Floodproofing was discarded since it could not be economically justified and for much of the area would be ineffective for the design flood. Relocation would be impractical, costly, and meet with public opposition.

## STRUCTURAL MEASURES

Three alternative structural flood control solutions were considered: (1) increase the upstream flood storage, (2) a combination plan to remove the downstream channel restriction along with the deepening of the existing Westfield River channel and the diversion of Little River out of the basin from a point between Cobble Mt. Dam and Crane Pond and (3) provide a local protection system of dikes, floodwalls, channel realignments and pumping stations.

## ALTERNATIVE FLOOD CONTROL SOLUTIONS

Alternative I - Upstream Storage - Flood control storage added to existing reservoirs or provided in new reservoirs was investigated. The existing Cobble Mountain Reservoir already controls most of the Little River basin and is not a contributing factor to flooding in Westfield. Adding flood control storage space in this reservoir would not be feasible. Adding storage to the Corps existing Knightville reservoir on the East Branch of the Westfield River would not be justified when compared to a local protection plan for the city of Westfield. Such a project could not be economically justified when viewed as "last added" in a system for flood control in the Westfield River Basin. The feasiblity of modifying Knightville Dam was presented in the Corps' report dated June 1978 and described in Section A of this Appendix.

Modifications to the existing dams at Woronoco and Russell were excluded. Raising these dams would require the relocation of U.S. Route 20 and a railroad within the reservoir areas. The higher water surfaces would have required the relocation of upstream towns with resulting serious social impacts. The raised pool also would eliminate miles of free flowing cold water streams.

A proposed high dam at Huntington was investigated but was discarded for the same reasons indicated for the Woronoco and Russell reservoirs.

Upstream storage was considered on the Little River at the proposed Horton Dam and Reservoir. The Horton Dam would be located on the Little River about five an one-half miles upsteam from its confluence with the Westfield River and about two miles west of the center of the city of Westfield. The dam would be a rolled earthfill structure with a length of 3,000 feet and a maximum height of 85 feet above the streambed.

The Horton Dam site was discarded from further considerations because it would be relatively ineffective in reducing flood stages in the city of Westfield. In all storms except August 1955 the reservoir would be able to store all the runoff; storage would have been completely utilized and some spillway discharge would have occurred. The spill discharge would have occurred during the flood recession on the Westfield River and would not have synchronized with the peak flows of the uncontrolled areas which would already have caused flood damages in the flood plain. Further, it cannot be justified economically, having a benefit cost ratio of less than unity. The social and economic impact of the considerable relocations of homes, families, and roads within the heavily built-up reservoir areas would be enormous.

Alternative II - River Improvements - Downstream river improvements of removing constrictions and deeping of the Westfield River, along with the Little River diverison were considered.

a. The location of the constriction on the Westfield River is approximately one-half mile downstream from the U.S.G.S. gaging station of the Westfield River near Westfield, Mass. The work would consist of excavating about 1.5 million cubic yards of earth excavation, 0.7 million cubic yards of rock excavation and the relocation of about one half mile of U.S. Route 20. This was discarded from further considerations since it would substantially worsen the flood problems to the downstream communities. Since mitigation of worsened conditions downstream are project costs, these added to the construction costs of the widening would made this alternative uneconomical. Also, the political pressures from the downstream communities due to the increase in flooding potential after removal of the constriction

would require an increase in height of their existing flood protection. The construction of downstream protection works would cause a disruption in the daily life of the community with corresponding negative economic and social impacts.

b. Consideration was given to the diversion of the Little River. This diversion would start on the Little River upstream of Hortons Bridge and terminate in the Westfield River about two miles upstream of the Elm Street Bridge. The diversion would consist of about 2500 feet of channel and 2500 feet of tunnel. This was found to be technically impractical since it would not provide adequate flood protection for the city of Westfield. This plan would require significantly higher dike construction along the Westfield River for the city's protection. Also, dikes would still be required along the Little River to protect against the backwater flooding from the Westfield River. For the above reasons this alternative was discarded from further consideration.

Alternative III - Local Protection - Of the structural alternatives considered for the solution of Westfields' flooding problem the most practical was local protection, combined with nonstructural measures. The nonstructural measures considered adaptable with local protection are flood insurance and flood plain zoning for those flood prone areas not protected.

Eight plans were studied in detail to arrive at those which would satisfy the National Economic Development, (NED), and Environmental Quality (EQ) criteria.

Plan 1 - Plan 1 as shown on Plate E-1 is essentially the same as the plan developed in the Corps' General Design Memorandum dated December 1963; the only difference being that abandoned stream channels within the proposed dike system would be filled in. This plan would protect the area of the city of Westfield generally between the Westfield and Little River.

The protection would consist of an earth dike, channel relocations on the Westfield and Little Rivers and other related structures including a pumping station and others related to drainage.

The dike would begin on the right bank of the Westfield River, north of Russell Road (Route 20), and continue downstream past Elm Street to the Chapman Playground area, where the proposed relocated Westfield River channel would begin. The relocated channel would follow through generally open land to meet the existing Westfield River channel. It then would continue across Route 20 to meet the relocated Little River channel and thence continue westerly along the left bank of the existing and improved Little River channel across Southwick Road and ending at the Stevens Paper Mill dam at Crane Pond. Short reaches of concrete walls would be used in the vicinity of Southwick Road, East Main Street, and Elm Street where space limitations would prohibit earth dikes.

The height of the dikes and concrete walls would vary. The average height of the dike along the Westfield River would be about fourteen feet and along the Little River about seventeen feet. The top width of all dikes would be ten feet. Side slopes would vary from 1V on 2H to 1V on 3.5H.

Relocated channels for portions of both the Westfield and Little Rivers would extend the confluence easterly about 4000 ft. from its present location to the Little River Road - East Main Street intersection area. The relocated Westfield River channel, approximately 7500 feet in length would extend from a point about 3000 feet east of Elm Street, follow an alignment just south and parallel to the Penn Central tracks to the new confluence with Little River. There would be two channel relocations on the Little River. One relocation would extend from a point about 2000 feet east of Southwick Road downstream approximately 400 feet to the Penn Central Transportation Company tracks. The other Little River relocation, also about 4000 feet in length, would extend the river to the new confluence and eliminate a sharp northerly turn in the existing channel.

An opening through the dike for the Penn Central tracks would be controlled by a sandbag structure to be erected when necessary for closure. Permanent street gates would be provided for the East Main Street and Southwick Road openings.

Four ponding areas would be provided for temporary storage of interior drainage within the dike system. The Shepard Street, Riverside and South Meadow ponding areas would be drained by gravity through gated conduits. The East Main Street ponding area which would utilize the unfilled portions of the abandoned River channels for storage, would require a pumping station for drainage.

The features of Plan 1 including lengths and numbers are summarized in Table E-1.

Plan 1 was presented to the public in 1965. A statement of assurance for participation in sharing the non-Federal costs of the plan was defeated by referendum vote. Lack of flood protection for the northern part of the city, in the Union Street area, appeared to be the main reason for lack of support. Plan 2 was proposed to include protection for the area.

Plan 2 - Plan 2 as shown on Plate E-2 would be the same as Plan 1 except that protection would be provided for the Union Street area between the Westfield River and Powdermill Brook.

The Union Streeet Dike protection would consist of an earth dike, a channel relocation on Powdermill Brook, a pump station and related structures.

The earth dike would extend from about 600 feet downstream of the Elm Street Bridge along the left bank of the Westfield River to a point about 5500 feet downstream then turn northerly to Powdermill Brook where it would follow the right bank of the brook and relocated channel until ending just east of Elm Street.

Concrete walls would be required where space would prohibit the use of earth dikes.

The height of the dikes and concrete walls would vary. The average height of the dike along Powdermill Brook would be about fifteen feet, and along the Westfield about fourteen feet. The top width of the dike would be ten feet. Side slopes would vary from 1V on 2H to 1V on 3.5H.

The Powdermill Brook channel just downstream of North Elm Street would be relocated into a new 600 foot channel just north of the existing channel.

Street gates would be required for openings in the dike where streets pass through the dike. A railroad gate would be provided at the Penn Central Transportation Company track crossing.

A pumping station would be constructed for interior drainage for the Union Street area dike. The features of Plan 2 including length and numbers are summarized in Table E-1.

Plan 2 is not technically acceptable because of the decrease in flood plain storage due to the construction of the Union Street Area Protection. The loss of storage would increase downstream flood stages worsening conditions at the existing developed properties and affecting the existing West Springfield Local Protection Project. The cost of mitigating the impact to existing development would add to the cost of the Westfield Local Protection Project. Furthermore, the environmental impacts of filling and abandoning the existing river channel, the effects of constructing new river channels were opposed at a public hearing held in 1975. Accordingly Plan 2 was eliminated from further consideration. Due to the environmental questions received and the loss of flood plain storage resulting from the construction of the flood protection of the Union Street Area, Plans 3 and 4 were formulated.

Plan 3 - Plan 3 as shown on Plate E-3 was developed in response to the concerns expressed for Plan 2. This plan would retain the existing stream channels of the Westfield and Little Rivers and Powdermill Brook in their present state, except for the 1,600 foot long channel relocation of Powdermill Brook east of Elm Street.

A dike along the Westfield River would extend from the same location as in Plan 1 north of Russell Road and continue downstream of the right

bank of the Westfield River to the present confluence with the Little River, thence upstream along the left bank of the existing Little River channel, across Southwick Road to the Stevens Paper Mill dam at Crane Pond.

The Union Street area dike would extend from the Elm Street Bridge, follow along the left bank of the Westfield River downstream to a point easterly of the sewage treatment plant, turn sharply in a northerly direction through generally open land across the railroad tracks and Union Street to Powdermill Brook. It then would continue upstream along the right bank of Powdermill Brook to a point a short distance west of North Elm Street where it would meet high ground.

A third dike would extend from the northerly side of Munger Hill below Ridgecrest Drive would continue along the right bank of the Little River and across Route 20 to the junction with the Westfield River. It would then continue downstream along the right bank of the Westfield River across Route 20 and then across Route 187 (Little River Road) to meet high gound on the easterly side of Munger Hill a short distance to the south of Ridgecrest Drive. Concrete walls would be constructed in reaches where limited space precludes the use of earth dikes.

Plan 3 would eliminate the need for a temporary ponding area along the abandoned reaches of the Westfield and Little Rivers, and would require four instead of two pumping stations. The more than one mile greater length of concrete wall, plus the added number of street gates and pumping stations, would increase the cost appreciably over that of Plan 2.

The features of Plan 3 including the lengths and numbers are summarized in Table E-1. Plan 3 was presented to the public in a meeting in March 1975. The public found the plan unacceptable due to high costs, diversion of the city into isolated segments, decreased mobility within the city and loss of business activity due to loss of visibility by street gates, etc. The plan was eliminated from further consideration.

<u>Plan 4</u> - Even though Plans 2 and 3 were not considered as viable alternatives, some components of each plan were acceptable to the public and would not have signigicant negative impacts. These components were used as the basis of Plan 4. Plan 4 shown on Plate E-4 attempted to develop the most likely NED Plan while reducing the environmental and social impacts of Plan 2 and 3. Plan 4 is basically a modified version of Plan 2, the major differences being a shorter length of the Westfield River channel relocation, elimination of the downstream 5,400 feet of improved Little River channel, and relocating the protective works in the vicinity of the intersection of East Main Street and Little River Road to result in more favorable aesthetic, social and environmental conditions.

The configuration of the protective works for Plan 4 is essentially that of Plan 2 with a changed alignment at the new Westfield River channel relocation, the Little River channel near Riverside Drive, and the area near Little River Road. The larger dike system begins at the same location north of Russell Road and continues downstream on the right bank of the Westfield River to just upstream of the sewage treatment plant, then cuts across the oxbow of the Westfield River on the right bank of the new channel, then continues upstream along the left bank of the existing Little River channel across Southwick Road and ends at the Stevens Paper Mill Dam at Crane Pond.

The Union Street area dike system begins at the same location as Plan 3 on the left bank of the Westfield River at the Elm Street bridge and continues downstream along the Westfield River and the new Westfield River channel, then turns northerly across generally open land across the railroad tracks an Union Street to Powdermill Brook. It then would continue along the right bank of Powdermill Brook to a point a short distance west of North Elm Street where it would meet high ground. Concrete walls would be used where limited space precludes the use of earth dikes.

Street gates and the railroad sandbag structure as described in Plan 1 would be provided at openings in the longer dike. A railroad gate and street gates would be provided for openings along the Union Street area dike.

Three ponding areas will be provided within the longer dike; Shepard Street and South Meadow Road Ponding Areas are described in Plan 1 and the third, East Main Street Pond will utilize the existing river channels within the protective works. The East Main Street Ponding area would be smaller than that indicated in the Plan 1 and would require an increase in the pumping station capacity as well as an increase in the size of conduit, in order to provide the same degree of protection as described in Plan 1. A pumping station would be provided for interior drainage of the Union Street area.

A summary of the features of Plan 4 is shown on Table E-1.

Plan 4 was presented at the March 1975 Public Meeting. The adverse environmental impact of filling the existing Westfield River and Little River channels within the protection, together with the negative visual impacts at the East Main Street junction of the protection, and the accompanying economic losses to businesses within this area made this plan unacceptable.

A large area of industrially-zoned land which is divided by the Union Street area protection was left out of the protected area. A request was made to include the remainder of this tract within the protected area. The input received from the public presentation of this plan led to the formulation of Plans 5, 6 and 7.

Plan 5 - This plan was developed to meet the criticism that visual and physical access to the river would be restricted by a local flood protection project. In the two locations where there is very little development the dikes system would be withdrawn from the river up to the built-up areas leaving two large areas of open land between the dike and the river channels. The other criticism that Plan 4 dike would divide the 160-acre track of industrially-zoned property was met by withdrawing the Union Street dike system northerly to the railroad tracks, similar to the configuration of the Union Street area dike system considered for Plan 2.

As shown on Plate E-5, the Union Street area dike system extends along the left bank of the Westfield River about one mile, then turns northeasterly, crossing the railroad tracks and Union Street to Powdermill Brook, then turns and extends northwesterly upstream along the right bank of Powdermill Brook until meeting high ground to the west of North Elm Street. The larger dike system also is similar to that of Plan 2, with three major changes.

The first change would be shortening the Westfield River Channel relocation and shifting it southerly to a point across the oxbow of the Westfield River, similar to Plan 4. The second change would be relocating a length of the dike away from the Westfield River bank in the reach immediately upstream of the oxbow. The suggested location would be along the old State dike that parallels Miller Street, preserving a large area between the dike and the river now operated as a farm. The third change would relocate approximately one mile of the dike away from the Little River in a northerly direction toward the built-up areas, which would retain a stretch of wooded land and a large part of a tobacco farm lying between the dike and the Little River.

As in the other plans concrete walls would be used where space would not permit the use of earth dikes. A summary of the features of Plan 5 are presented in Table E-1. The advantages of Plan 5 include a better opportunity for visual contact with the rivers, the retention of a tract of industrially-zoned property without dividing it and more area available to provide temporary flood plain storage which would result in a slight reduction in flood stages outside of the protected area.

The more obvious disadvantages include leaving the industrially-zoned tract unprotected, and dividing the tobacco farm. Additional disadvantages would result from relocating the portions of the dike closer to the built-up areas. One obvious impact would be the negative aesthetic effect of the dike being close to residential and commercial areas. In addition to the aesthetic impact is the possible economic impact of a reduction in property values, especially in residential neighborhoods.

A review of the access to the river indicated that while both visual and physical access at first might appear to be improved, closer evaluation determined that some of the private land between the dikes and the rivers would have to be purchased by the city for public access. Visual access to the rivers would be provided with Plan 5 mostly from the top of the dike which would be the case for all of the other plans. Since it is planned to use at least some of the dike system for a linear park or other public use, withdrawing the dike from the river for visual and physical access does not appear necessary.

These impacts when considered objectively, were determined to have significant effects within the immediate planning area, and these significant effects would be irreversible for the life of the project. The significant social effects were considered to be aesthetic and also a possible restriction on community growth (expansion into presently unoccupied land). The significant economic effects were considered to be an anticipated reduction in some property values, a restriction on the affected land use, and a present and future reduction in agricultural activity. The environmental effects resulting from the proposed change in alignment of dikes away from the rivers were not considered to be of any greater significance than those resulting from leaving the dikes along the river banks.

The public perceptions coincided with this objective analysis. Since there was agreement that the significant effects were essentially negative, Plan 5 was rejected from further consideration.

Plan 6 - This plan as shown on Plate E-6, is essentially a modification of Plan 4. The purpose of Plan 6 was to consider another possibility of protecting the 160 acre tract of industrially-zoned land north of the Westfield River oxbow without dividing the property. In Plan 5 this property would not be divided by the dike system, but it would be exposed to the effects of flooding. Plan 6 attempts to optimize the proposed protection by extending the Union Street dike system along the perimeter of the property, except for a 30-acre portion at Route 20 known as Frog Hole. Due to the narrow configuration of the Frog Hole area and the Route 20 alignment, protection of this area could not be economically justified. Further, the Frog Hole area is considered to be environmentally significant, thus leaving it unaffected by the protective works would be highly desirable. Further evaluation indicated that extending the dike system to protect the approximately 130 acres of industrially-zoned land would not be desirable. To do such would provide large benefits to a few beneficiaries. Since Plan 6 would provide windfall benefits to a single land owner, and since these benefits would be of a far greater magnitude to the single land owner than benefits occurring to the local regional or national interests, the economic effect of this plan would be adverse. The established policy is to require a local contribution in windfall land enhancement benefits, ususally as a cash contribution. The allocation of this cost is the responsibility of the local

entity. A preliminary cost estimate indicated that the total cost of this added length of dike would approach $3,000,000 raising the local costs from $2,800,000 to approximately $4,200,000. This was unacceptable to local officials and the general public. Since the current market value for the affected land is approximately $10,000 per acre, the cost sharing could be equal to or greater than the market value of the land remaining after the protection project is built.

A second significant effect would be the social impact. Because the land required for the dike would be a local cost, many city residents were opposed to using public funds for the advantage of a single individual. In an attempt to mitigate this attitude it was suggested that the land owner donate the land and any rights of way needed to build the added length of dike. While this suggestion did soften community objections, as did the further proposal of a donation of land to the city for a recreation area outside the dike and along the river, the response of the segment of the public continued to be negative. They felt that even though local costs might not be increased if the owner donated the land, the Federal money spent to construct the added length of dike still represented their tax dollars.

Due to the significant negative economic and social impacts, Plan 6 was rejected from further consideration.

Plan 7 - The various changes made to Plan 4 and considered in Plans 5 and 6 were reformulated to develop Plan 7 shown on plate E-7. The results of this analysis and those from public coordination enabled the combination of the desirable features of the other plans into this plan, while those features having negative social, economic or environmental impacts were minimized.

Plan 7 is a further modification of Plan 4, but would add three major changes and several minor revisions. The major changes would include retaining the Westfield and Little Rivers in their existing channels, relocating the Union Street dike away from the 160-acre tract of industrially-zoned area lying northerly of the oxbow of the Westfield River, and relocating the protective works at the intersection of Route 20 and Little River Road. The Westfield River would flow through two gated conduits where the dike twice crosses the Westfield River, and the Little River flows through one gated conduit where the dike would cross the Little River.

The revisions would include eliminating a street gate on North Elm Street as part of the redesigning of the protective works along Powdermill Brook and the Standard Radiator Company buildings and relocating the upper end of the Westfield River dike along Russell Road.

The configuration of the protective works for Plan 7 is essentially that of Plan 2 with the several changes noted above. As shown on

Plate E-7, the longer dike system begins in a similar location on the southerly side of the Westfield River, north of Russell Road (Route 20). However, instead of beginning on Russell Road at Fairfield Avenue and extending along the easterly side of the Muszynski farm to the Westfield River and then continuing downstream, the dike system would begin at high ground to the west of the Muszynski farm and then continue downstream along the right bank of the Westfield River past Elm Street to just upstream of the sewage treatment plant, cut across the oxbow of the Westfield River on the right bank of the new channel and continue downstream across Route 20, across the new Little River channel at the outlet to the conduit under Little River Road, turn to cross Little River Road, and tie into high ground at Munger Hill to the south of Ridgecrest Drive. The dike begins again on the northerly side of Munger Hill, just west of Tow Path Lane, crosses the new Little River channel at the inlet to the conduit under Little River Road, turn and follow the left bank in a westerly direction to meet the existing Little River channel, continues along the left bank of the Little River and the North Fork near Riverside Street, crosses Southwick Road and ends at the Stevens Paper Mill Dam at Crane Pond.

The Union Street area dike system would begin on the left bank of the Westfield River at the Elm Street bridge and continue downstream along the Westfield River for slightly more than one mile, then turns northeasterly and crosses the railroad tracks and Union Street to the right bank of Powdermill Brook then turns northerly and continues upstream along Powdermill Brook to North Elm Street where it would cross the brook to meet high ground.

The height of the dikes, flood walls, headwalls, and street gates would vary depending upon the elevation of the ground, flood stages at a given location, and related factors, as is true of each of the plans considered. The average height of the dike along Powdermill Brook would be about fifteen feet high, along the Westfield River about fourteen feet high, and along the Little River about seventeen feet high. The top width of all dikes would be ten feet. Slopes of the sides would vary from 1V on 2H to 1V on 3.5H. Concrete walls would be constructed in areas where space limitation would not permit construction of earth dikes.

Street gates would be installed at the several locations where the dike system crosses roadways, and a railroad gate would be installed where the dike crosses the Penn-Central tracks. Two pumping stations would be constructed to remove the collected interior runoff, and the treated effluent from the sewage treatment plant would be pumped through the dike into the new Westfield River channel.

The advantages of Plan 7 fall into two categories; advantages typical of local flood protection projects in general, and those specific to Plan 7. The advantages typical of local protection projects include positive flood protection for the enclosed area from the design flood and very little need for non-structural measures. Typical disadvantages include a slight increase of flood stages downstream of the

protected area and the resulting need for some form of mitigation, and the cost to the community of providing lands, easements and other items of local cooperation. The advantages specific to Plan 7 include providing flood protection to the optimum number of acres of flood plain while at the same time locating the dike as far from the rivers as possible to provide the maximum amount of temporary flood storage outside the protective works. The disadvantage of Plan 7 is its higher cost.

Plan 8 - This plan as shown on Plate E-8 was formulated to comply with the objectives of National Economic Development and thereby reduce the overall project costs. Consideration was given to the substitution of the Little River cutoff channel for the pressure conduit in the vicinity of Little River Road just before the channel's confluence with the Westfield River. All other features are as described for Plan 7.

The study indicated that the construction costs of the concrete pressure conduit included in Plan 7 would amount to 9.6 million dollars whereas the construction cost of the cutoff channel would be $582,000 with no costs included in either figure for real estate, engineering and design or supervision and administration.

The present day value of the Real Estate taking requirements in this reach of the project for the cutoff channel is $850,000 making the total cost of construction and real estate taking for the cutoff channel:

| | |
|---|---|
| Construction | $ 582,000 |
| Real Estate | 850,000 |
| Total | $1,432,000 |

There would be no comparable real estate takings for the pressure conduit required. The comparison then is between $1,432,000 cost for cutoff channel construction and real estate takings of a bank building and three houses with garages, versus the 9.6 million dollar cost for the concrete pressure conduit, a difference of 8.2 million dollars. Under these conditions the cutoff channel is recommended. Plan 8 represents the orderly development of the plan which meets the criteria of National Economic Development, Environmental Quality and interests of the area.

Those citizens who would be directly affected by the protection works in the vicinity of East Main Street and Little River Road prefer the use of a conduit under Little River Road as proposed in Plan 7.

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TABLE E-1
FEATURES OF PLANS

| FEATURE | UNIT | Plan Number 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Earth Dike | Lin. Feet | 30,900 | 42,900 | 50,900 | 46,200 | 44,000 | 53,400 | 40,200 | 39,000 |
| Concrete Wall | Lin. Feet | 2,500 | 4,300 | 10,400 | 4,100 | 4,300 | 4,500 | 2,600 | 3,700 |
| New Channel Excavation | Lin. Feet | 16,900 | 18,500 | 1,600 | 14,000 | 16,000 | 15,800 | 11,900 | 11,900 |
| Existing Channel Abandoned or Filled | Lin. Feet | 15,500 | 17,500 | 1,500 | 6,000 | 12,000 | 9,000 | 7,000 | 7,000 |
| Pumping Station | Each | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| Street Gate | Each | 2 | 6 | 9 | 6 | 6 | 6 | 5 | 5 |
| Railroad Gate | Each | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Gated Conduit | Each | 5 | 5 | - | 1 | 5 | 2 | 7 | 7 |
| Ungated Conduit | Each | 1 | 1 | - | 2 | 1 | 2 | 1 | 1 |
| Pressure Conduit | Each | - | - | - | 1 | - | 1 | 2 | 1 |
| New Highway Bridge | Each | 1 | 1 | - | - | 1 | - | - | 1 |
| Sandbag Closure Structure | Each | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 2 |
| Interior Drainage Ponding Area | Each | 5 | 6 | - | 4 | 6 | 5 | 6 | 6 |
| Utility Relocation | Each | As Reqd | As Reqd | As Reqd | As Reqd | As Reqd | As Reqd | As Reqd | As Reqd |

TABLE E-2

FIRST COSTS & ANNUAL COSTS
FOR ALTERNATIVE PLANS
MARCH 1978 ($1,000 UNITS)

| Plan No. | FIRST COSTS Federal | Non-Fed. | Total | ANNUAL COSTS Federal | Non-Fed. | Total |
|---|---|---|---|---|---|---|
| 1 | $20,100 | $ 4,000 | $24,100 | $ 1,526 | $ 314 | $ 1,840 |
| 2 | 31,700 | 4,700 | 36,400 | 2,406 | 377 | 2,783 |
| 3 | 50,100 | 4,600 | 54,790 | 3,804 | 369 | 4,173 |
| 4 | 35,100 | 4,900 | 40,000 | 2,665 | 392 | 3,057 |
| 5 | 34,200 | 4,700 | 38,900 | 2,597 | 377 | 2,974 |
| 6 | 49,200 | 4,440 | 53,600 | 3,736 | 354 | 4,090 |
| 7 | 44,700 | 4,000 | 48,700 | 3,394 | 324 | 3,718 |
| 8 | 34,300 | 4,800 | 39,100 | 2,600 | 380 | 2,980 |

TABLE E-3

ANNUAL BENEFITS FOR ALTERNATIVE PLANS
($1,000 UNITS)

| Plan No. | Flood Damage Prevention | Location | Affluence | Negative Benefits | Total Benefits | B/C Ratio |
|---|---|---|---|---|---|---|
| 1 | 3,341.8 | 38.8 | 100.2 | -51.9 | 3,428.9 | 1.86 to 1.0 |
| 2 | 3,462.6 | 146.5 | 111.3 | -12.7 | 3,707.7 | 1.33 to 1.0 |
| 3 | 3,481.4 | 146.5 | 111.3 | -12.7 | 3,726.5 | 0.89 to 1.0 |
| 4 | 3,481.4 | 146.5 | 111.3 | -12.7 | 3,726.5 | 1.22 to 1.0 |
| 5 | 3,462.6 | 146.5 | 111.3 | -12.7 | 3,707.7 | 1.25 to 1.0 |
| 6 | 3,481.4 | 146.5 | 111.3 | -12.7 | 3,726.5 | 0.91 to 1.0 |
| 7 | 3,462.6 | 146.5 | 111.3 | -12.7 | 3,707.7 | 1.0 to 1.0 |
| 8 | 3,462.6 | 146.5 | 111.3 | -12.7 | 3,707.7 | 1.24 to 1.0 |

# *EFFECTS ON OBJECTIVES*

NATIONAL ECONOMIC DEVELOPMENT

For economic assessment purposes, first costs, annual charges, and annual benefits were estimated for each of the eight plans. Federal first costs include construction costs reflecting the March 1978 price level, an allowance for contingencies, engineering and design, supervision and administration and overhead. Non-Federal first costs are costs to be borne by local interest associated with land purchases, damages, and relocations. Property valuations are based on the fair market value and reflect values indicated by recent sales in the area. Interest charges during construction were included in the first costs. It was estimated that the period of construction would be three years.

Annual charges, both Federal and non-Federal are based on an interest rate of 6-7/8 percent amortized for 100 years. Included with the non-Federal annual charges are the estimated annual costs for operation and maintenance of the project, interim replacements and loss of productivity. Annual benefits include those for flood damage protection from the SPF flood, future inundation, location, affluence, and for area redevelopment because of the increased labor required for construction of the project.

Summaries of Federal and non-Federal first costs an annual benefits with benefit cost ratios are presented in Table E-2 and E-3 respectively. The derivation of these costs and benefits for the selected plan is given in Section G.

ENVIRONMENTAL QUALITY

Wildlife - The city of Westfield and the surrounding area is urbanized; for this reason there is not a large assemblage of wildlife present. However, the rivers and adjacent shoreline support a population of small mammals -- those capable of living in close proximity to man -- such as mink, weasel, foxes, raccoon, and others. Even in these areas, however, man's domestic animals prey upon wildlife; thus keeping this population down. A major portion of the watershed above Westfield is a wilderness area, and therefore contains a substantial population of wildlife, and also serves as a recreational area for the urbanized areas.

Urbanization has also reduced the quality of the water found in the river system. Studies have shown that the two major rivers, the Little and Westfield, contain very few species of fish, and those present are capable of withstanding the effects of pollution. There are some small areas in and near the city that contain a naturally reproducing trout population, but on the whole the lower drainage basin is not ideal sport fish habitat. This may change as the quality of the water improves, however.

Vegetation - Natural vegetation in Westfield is primarily oak-hickory woodland on the uplands, Maple-Linden-Elm woodland on seasonally wet soils along water courses, and grasses and herbs in open fields. Within the city, woodland is limited to steep slopes, wet soils, river banks, parks and small privately owned tracts.

EFFECTS ASSESSMENT

To control flooding in accordance with the objectives of fostering economic development and improving the quality of the environment eight plans have been formulated. All eight plans would have some similar impacts. Other impacts would be unique to a specific plan.

Social and Economic Assessment - All eight alternative plans are local protection type plans which would exhibit similar social and economic impacts. Social and economic impacts would be observed during the two periods of the project's expected life; construction phase, and post-construction phase. Construction phase impacts are generally temporary effects that result from the construction activities. The post-construction phase is that period of time following the removal of workers and equipment from the construction site. This phase continues throughout the project-life of 100 years and is characterized by permanent and irreversable changes.

Construction phase impacts include increased temporary employment, increased purchase of goods, materials and services, increased noise, and air pollution and traffic on local roads. With the exception of temporary employment, these impacts are site-specific and require knowledge of the area where dike construction will take place

and roads on which construction materials will be transported in order to identify the extent of an impact's occurrence. The impact of increased temporary employment will depend on the number of workers and types of skills required and if locally hired.

During the construction phase approximately 125 acres of land would be taken in temporary easements. This land will be used for movement and storage of equipment and construction materials as well as construction of temporary roads to permit easy access to areas where the dike would be placed.

The post-construction phase would be characterized by increased flood control protection for the city of Westfield. Implementation of any of the structural plans will result in protection from approximately 1700 acres of the 3100 acres now subject to periodic flooding.

Increased flood control protection would result in a reduction of damages to homes and commercial establishments, damages to roads and highways, temporary losses of work, and costs associated with cleanup.

At this stage of the study, there is a very real possibility that some relocation of homes and commercial establishments would be necessary. The areas of particular concern are Park Street, Delancey Street, Little River Road, and East Main Street at Little River Road. Until detailed design is undertaken, it is uncertain as to how many properties could be involved. Some plans, especially Plan 5, would require significant taking of agricultural land, and splitting one farm in half.

With the reduction of flood hazard, a net increase in land values is anticipated. It is also expected that this reduction will encourage investment and development in newly protected areas.

Environmental Assessment - In evaluating the environmental impacts associated with the alternative plans it is important to identify those features of the project which might cause significant impacts, and then compare the plans to determine which are most environmentally sound. For Westfield, there are two aspects where significant impacts might arise from the proposed plans. These are the impacts on the river banks and channels during and after construction, and the disruption of land used as new borrow sites for fill needed for the dikes.

Impact I - In constructing the dikes and walls, the river banks and channel would be severely impacted. This occurs because the river banks would be shaped. Riprap or other means of bank protection would be placed on some areas of the channel and the river bank where erosion might occur. Consequently, heavy equipment would work along the banks and in the channel, resulting in the death of some organisms in these areas. Dike and wall construction would also have a significant

aesthetic impact in the almost total loss of extensive narrow strips of woodland that typically border the streams within the city. In addition, for a period of time the dike's slopes and river banks would be exposed to erosion; the added silt could smother some benthic organisms, and reduce the opportunity of fish, which feed by sight, to forage.

Those areas where walls would be constructed would not be as severely impacted since no dike material would be exposed to erosion. However, the banks adjacent to the walls would still require shaping and possibly bank protection. Plants in these areas would be lost.

The impacts from the dikes would not be all negative, for if the dikes are properly landscaped an edge is created. Edges are areas that break up or blend two ecosystems, and it has been found that such areas can contain a great variety of organisms. In Westfield this effect would be limited to those organisms capable of living near man. To a limited extent, the disrupted stream channel would also recover. Insects and bottom dwelling organisms would rapidly recolonize the area. However, this may not occur with some species of fish in the construction area since they need deep holes as well as shallow areas. Channels constructed by man are typically wide shallow areas which are efficient for carrying water out but may not be favorable for wildlife habitat. The aesthetic impact of the dikes and walls, and the vegetation lost due to construction can also be partially mitigated. Mitigation measures may include screening of the new structures with new plantings, and architectural treatment of walls in areas of high visibility.

Impact II - All eight plans would require a borrow site. The extent of the borrow operations would depend upon the length of the dikes and upon usable material removed from the new channels, and other required excavations.

All eight plans would call for the construction of dikes, walls, and new channels -- some more than others. Table E-1 displays the total length of the dike and walls required for each plan and the total length of new channel bottom created and existing channel bottom abandoned or filled.

From the prior discussion, four plans -- 1,3,7, and 8 emerged as possibly having the least environmental impacts:

Plan 1 would disrupt the least area of stream bank, and would also require the least amount of fill for the dikes. On the other hand, it would disrupt the greatest length of natural channel.

Plan 3 would create the longest dike and wall system, and therefore, would have a substantial impact upon the stream banks and the greatest visual impact. Further, it would require more fill from the borrow site but only 1,500 feet of natural stream channel would be lost.

Plans 7 and 8 would essentially have equal environmental impacts, and will therefore be evaluated as one plan against 1 and 3. Plans 7 and 8 would disrupt less stream bank and channel than plan 3, but more than plan 1. As far as natural channel loss there would be less with plans 7 and 8 than with plan 1. Consequently, plans 7 and 8 would also have the least visual impact since more of the construction impact would be located in areas of low visibility. Consequently, plan 7 and 8 appear to be the most environmentally acceptable plans.

Archaeological Assessment - A cultural resource reconnaissance was performed within the project area. A report containing the results of the reconnaissance is contained in Appendix 3 and summarized, as it relates to the alternative plans in this section.

The reconnaissance study resulted in identification of 36 historic and prehistoric cultural resources, 28 of which were recommended for further study if the project proceeds to design stage. One of these, the Hampden Feede Canal, is being nominated by local interest to the National Register of Historic Places.

Impacts to cultural resources from any of the proposed alternative plans are anticipated to be similar in scope. For a variety of reasons, some segments of the project routes could not be covered at the time of study. Therefore, estimates of expected sites additional to those presently located are provided in the table E-4.

The frequency of sites within the surveyed areas was found to be extremely dense: averaging at one site per 2,000 feet.

Table E-4

ARCHAEOLOGICAL SITES: KNOWN AND ESTIMATED

| Plan No. | Known Sites | Estimated Additional Sites | Total |
|---|---|---|---|
| 1 | 21 | 7 | 28 |
| 2 | 25 | 7 | 32 |
| 3 | 27 | 9 | 36 |
| 4 | 27 | 2 | 29 |
| 5 | 27 | 8 | 35 |
| 6 | 27 | 4 | 31 |
| 7 | 28 | 1 | 29 |
| 8 | 28 | 1 | 29 |

Though those plans with the least number of sites impacted may appear most desirable with respect to cultural resources management, this may not actually be the case. The eligibility of sites for inclusion in the National Register of Historic Places has not been assessed within the present level of study. As mitigation of adverse effect would be required only for eligible sites, the number of such sites would be more important in assessing impact of various plans than would the

total number of sites present within the project area. In view of this, and because the variation between plans in the number of sites impacted is relatively small, impacts resulting from any one plan are not expected to significantly differ from those of other plans.

## *SELECTING A PLAN*

Plan 1 has the lowest first cost of any plan considered. However, the large unprotected area of Union Street made this plan unacceptable to the public. Plan 2 also has a low first cost, however, this plan would abandon the existing river channels within the protected area leaving them dry. This was aesthetically, socially and environmentally unacceptable to the public. Plan 8 is primarily Plan 2 with provisions added to provide flow in the exisitng river channels within the protection and best meets the desires of the community. Consequently, it was judged that the intangible environmental, social, and aesthetic advantages of plan 8 would offset its extra cost and it was chosen as the Selected Plan.

## *DISPLAY OF ALTERNATIVE PLAN EFFECTS*

The Water Resources Council's Principles and Standards requires that all alternative plans carried through final planning stages be evaluated against both planning objectives and Federal objectives or accounts of National Economic Development (NED), Environmental Quality (EQ), Social Well-Being (SWB), and Regional Development (RD). In cases where two alternatives are quite similar, only the most acceptable or efficient alternative needs to be displayed. Accordingly, two of the three alternatives considered, upstream storage and river diversion with channel improvements, were not carried through the final planning stage. The third alternative Local Protection considered eight plans which were carried though final planning stages.

The mechanism for displaying each plan's significant contributions to the objectives is called the System of Accounts (SA) Display. This display allows tradeoffs among the plans to be compared. More specifically, the System of Accounts displays each plan and presents each plan's performance against objectives, as well as applying other

evaluation criteria of timing, geographical incidence, uncertainty, exclusivity and actuality to each plan's impacts.

Table E-5 provides the System of Account information required by the Principles and Standards. A detailed explanation of this table is provided in the following paragraphs.

Alternatives Displayed - Eight plans of the local protection alternative were investigated in the final planning stages. Since all eight plans are basically dike plans with minor variations only three plans; the most economical plan (Plan 1), the plan most acceptable to the public (Plan 7) and the selected Plan (Plan 8) are evaluated in the System of Accounts display.

Study Objectives - Each plan displayed addresses the planning objectives to develop economically and environmentally acceptable flood protection measures for the city of Westfield. Both beneficial and adverse contributions of each plan's impacts to the four Federal objectives are displayed in the SA table. Impacts or effects designated in Section 122 of the River and Harbor and Flood Contorl Act of 1970, as necessary in the evaluation of water resources project are noted with an asterisk (*).

Regions Displayed - Principles and Standards require that impacts of effects be evaluated according to geographical regions in which a significant portion of any beneficial of adverse impact will occur. As a minimum, at least one region and the remainder of the Nation must be shown. In the study, effects on only two areas, Westfield River watershed and the remainder of the Nation, are displayed as they were found to be the only regions consistently receiving significant impacts.

Other Evaluation Criteria - It is also required that certain specified evaluation criteria be applied to alternative plans to test their responsiveness to various objectives and facilitate the analysis of trade-off amongst alternative plans. These criteria are listed below with code numbers used in the SA display.

a. Timing

Code

| | |
|---|---|
| "1" | Impact expected to occur prior to or during plan implementation. |
| "2" | Impact estimated to occur within 15 years following plan implementation |
| "3" | Impact estimated to occur 15 or more years following plan implementation |
| "+" | Impact occurs at indicated time period and continues for an indefinite future period. |

b. Uncertainty

Code

"4" The uncertainty associated with the impact is greater than 50%

"5" The uncertainty is between 10% and 50%

"6" The uncertainty is less than 10%

c. Exclusivity

Code

"7" Overlapping entry; fully monetized in NED account.

"8" Overlapping entry; not fully monetized in NED account.

d. Actuality

Code

"9" Impact will occur with implementation

"10" Impact will occur only when specific additional actions are carried out during implementations.

"11" Impact will not occur because necessary additional actions are lacking.

Table E-5 is set up to address each major alternative plan impact on the four Federal objectives. Timing is indicated by a code of "1", "2" or "3": region of impact is indicated by "Yes", "No" or "NS" (Not Significant). Other evaluation criteria are noted in parentheses under the region of impact. Plan 1 has the highest benefit to cost ratio and also maximized net economic benefits, therefore, it is the National Economic Development (NED) Plan. Plans 7 and 8 have similar adverse environmental impacts. Plan 7 is the Environmental Quality (EQ) Plan. However, Plan 8 because of its lesser economic cost is the Selected Plan.

TABLE E-5

SYSTEM OF ACCOUNTS

WESTFIELD LOCAL PROTECTION

WESTFIELD, MASSACHUSETTS

| | | PLAN NO. 1 | | PLAN NO. 7 | | PLAN NO. 8 | |
|---|---|---|---|---|---|---|---|
| | Impact Codes | Planning Area | Remainder of the Nation | Planning Area | Remainder of the Nation | Planning Area | Remainder of the Nation |
| (1) NATIONAL ECONOMIC DEVELOPMENT (NED) | | | | | | | |
| A. PROJECT FIRST COSTS | | | | | | | |
| Federal | 1,6 | $20,100,000 | U.S. share of Project Cost $22,355,000 | $44,700,000 | U.S. share of Project Cost is $49,100,000 | $34,300,000 | U.S. share of Project Cost is $37,800,000 |
| Non-Federal | 1,6 | 4,000,000 | | 4,000,000 | | 4,800,000 | |
| TOTAL | | 24,100,000 | | 48,700,000 | | 39,100,000 | |
| B. FLOOD DAMAGES | | | | | | | |
| Average Annual Flood Damages | 1 | $ 4,331,000 | | 4,331,000 | | 4,331,000 | |
| Annual Residual Damages | 1 | 1,041,100 | | 881,100 | | 881,100 | |
| Annual Flood Damage Reduction | 1 | 3,289,900 | | 3,449,900 | | 3,449,900 | |
| C. AVERAGE ANNUAL BENEFITS | | | | | | | |
| Flood Damage Prevention | 2+,9 | 3,341,800 | | 3,462,600 | | 3,462,600 | |
| Location Benefit | 2+ | 38,800 | | 146,500 | | 146,500 | |
| Affluence Benefit | 2+ | 100,200 | | 111,300 | | 111,300 | |
| Negative Benefits | | -51,900 | | -12,700 | | -12,700 | |
| TOTAL BENEFITS | | 3,428,900 | | 3,707,700 | | 3,707,700 | |
| D. AVERAGE ANNUAL COST | | 1,840,000 | | 3,718,000 | | 2,980,000 | |
| E. BENEFIT COST RATIO | | 1.82 | | 1.00 | | 1.24 | |
| (2) ENVIRONMENTAL QUALITY (EQ) | | | | | | | |
| A. AIR QUALITY | | | | | | | |
| Reduces air quality during plan implementation | 1,6,9 | Yes, moderate air & noise pollution during construction. | No. Overall air quality is not affected. | Yes. Same as Plan 1. | No. Same as Plan 1. | Yes. Same as Plan 1. | No. Same as Plan 1. |

TABLE E-5 (Continued)

| | Impact Codes | PLAN NO. 1 Planning Area | PLAN NO. 1 Remainder of the Nation | PLAN NO. 7 Planning Area | PLAN NO. 7 Remainder of the Nation | PLAN NO. 8 Planning Area | PLAN NO. 8 Remainder of the Nation |
|---|---|---|---|---|---|---|---|
| B. ARCHEOLOGICAL PROPERTIES | | | | | | | |
| Disturbs known archeological or historical resources | 1,6,9 | Yes. Impact could be significant. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |
| C. BIOLOGICAL RESOURCES | | | | | | | |
| Increases disruption of fish habitat along Powdermill Brook, Westfield and Little Rivers | 1,6,9 | Yes. Slight impact. | No. National fishery resources not affected. | Yes. Same as Plan 1. | No. Same as Plan 1. | Yes. Same as Plan 1. | No. Same as Plan 1. |
| Increases disruption of wildlife habitat within the project area. | 1,6,9 | Slight impact, but could be positive. | | Yes. Same as Plan 1. | | Yes. Same as Plan 1. | |
| Increases impact on vegetation within the proposed project area. | 1,6,9 | Conversion of wooded, farm and open land to a grassed dike. | | Yes. Same as Plan 1. | | Yes. Same as Plan 1. | |
| Creates temporary disruption of vegetation and wildlife in project area during plan implementation | 1,6,9 | Slight impact - not extensive in the urban area. | | Yes. Same as Plan 1. | | Yes. Same as Plan 1. | |
| D. NATURAL AND MAN-MADE RESOURCES | | | | | | | |
| Commits natural resources such as earth materials for plan implementation | 1,6,9 | Yes. Large quantities of earthfill and concrete required. | No. Does not affect nationwide materials required. | Yes. Same as Plan 1. | No. Same as Plan 1. | Yes. Same as Plan 1. | No. Same as Plan 1. |

TABLE E-5 (Continued)

| | Impact Codes | PLAN NO. 1 Planning Area | PLAN NO. 1 Remainder of the Nation | PLAN NO. 7 Planning Area | PLAN NO. 7 Remainder of the Nation | PLAN NO. 8 Planning Area | PLAN NO. 8 Remainder of the Nation |
|---|---|---|---|---|---|---|---|
| Commits man-made resources such as concrete, steel, etc. for plan implementation. | 1,6,9 | Yes. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |
| Conserves natural and man-made materials that would have been damaged or destroyed by future floods. | 1+,6,9 | Yes. Protects a highly developed urban center. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |
| Commits labor and energy for plan implementation. | 1,6,9 | Yes. | No. Only a very small percent of national total needed. | Yes. More than Plan 1. | No. Same as Plan 1. | Yes. More than Plan 1. | No. Same as Plan 1. |
| Improves drainage characteristics of existing channel during flood periods | 2+,6,9 | No. Existing channel would be abandoned. | Yes. Flood flows are diverted. | Yes. Flood flows are diverted. | | Yes. Flood flows are diverted. | |
| (3) SOCIAL WELL-BEING (SWB) | | | | | | | |
| A. ESTHETIC VALUE | | | | | | | |
| Increases open space | 1+,6,9 | Ponding areas will be retained as open space. Top and sides of dike will remain as open space. | | Ponding areas will be retained as open space.Top and sides of dike will remain as open space. | | Ponding areas will be retained as open space.Top and sides of dike will remain as open space. | |
| Increases visual impact of structure | 1,5,9 | Yes. Dikes are visible. | | Yes. More than Plan 1. | | Yes. More Plan 1. | |
| Creates temporary disruption of esthetic values during construction | 1+,6,9 | Yes. Use of any construction equipment. | | Yes. More than Plan 1. | | Yes. More Plan 1. | |

TABLE E-5 (Continued)

| | Impact Codes | PLAN NO. 1 Planning Area | PLAN NO. 1 Remainder of the Nation | PLAN NO. 7 Planning Area | PLAN NO. 7 Remainder of the Nation | PLAN NO. 8 Planning Area | PLAN NO. 8 Remainder of the Nation |
|---|---|---|---|---|---|---|---|
| B. NOISE | | | | | | | |
| Creates temporary increase in noise levels during plan implementation. | 1,6,9 | Yes. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |
| C. DISPLACEMENT OF PEOPLE | | | | | | | |
| Requires a relocation of residents or other buildings. | 1,6,9 | Yes. | | Yes. | | Yes. | |
| Reduces relocation of the population and businesses during and after floods. | 3+,6,9 | Yes. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |
| D. COMMUNITY COHESION | | | | | | | |
| Causes neighborhood disruption in residential area. | 1,6,9 | During implementation - Yes. No permanent disruption. | | During implementation, more than Plan 1. No permanent disruption. | | During implementation, more than Plan 1. No permanent disruption. | |
| Continues existing community living patterns during and immediately after floods. | 3+,6,9 | Yes. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |
| E. LIFE, HEALTH AND SAFETY | | | | | | | |
| Decreases threat to human life and safety during flood conditions. | 3+,6,9 | Yes. | No. Not a nationwide threat. | Yes. More than Plan 1. | No. Same as Plan 1. | Yes. More than Plan 1. | No. Same as Plan 1. |
| Decreases threat to health conditions during and after flood conditions. | 3+,6,9 | Yes. | No. Not a nationwide threat. | Yes. More than Plan 1. | No. Same as Plan 1. | Yes. More than Plan 1. | No. Same as Plan 1. |

TABLE E-5 (Continued)

| | Impact Codes | PLAN NO. 1 Planning Area | PLAN NO. 1 Remainder of the Nation | PLAN NO. 7 Planning Area | PLAN NO. 7 Remainder of the Nation | PLAN NO. 8 Planning Area | PLAN NO. 8 Remainder of the Nation |
|---|---|---|---|---|---|---|---|
| F. PUBLIC FACILITIES AND SERVICES | | | | | | | |
| Increases flood protection of public facilities and services. | 3+,6,9 | Yes. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |
| Increases the mobility of public services within the protected area. | 3+,6,9 | Yes. | | Yes. more than Plan 1. | | Yes. More than Plan 1. | |
| G. LOCAL DESIRES | | | | | | | |
| *Is consistent with local* desires. | 2,6,9 | No. Objection to abandoning existing river, bed and desire more of urban area be protected. | | Yes. Objections to Plan 1 have been met. | | No. Object to open channel. | |
| H. DESIRABLE COMMUNITY GROWTH | | | | | | | |
| Agrees with long range land use plans. | 2+,6,9 | No. Same as G. above. | | Yes. Same as G. above. | | No. Same as G. above. | |
| I. TRANSPORTATION | | | | | | | |
| Disrupts traffic in vicinity of project during plan implementation. | 1,6,9 | Yes, temporarily. | | Yes, temporarily. | | Yes, temoprarily. | |
| Reduces traffic problems during flood conditions. | 3+,6,9 | Yes. Allows traffic flow within protected area during flooding. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |

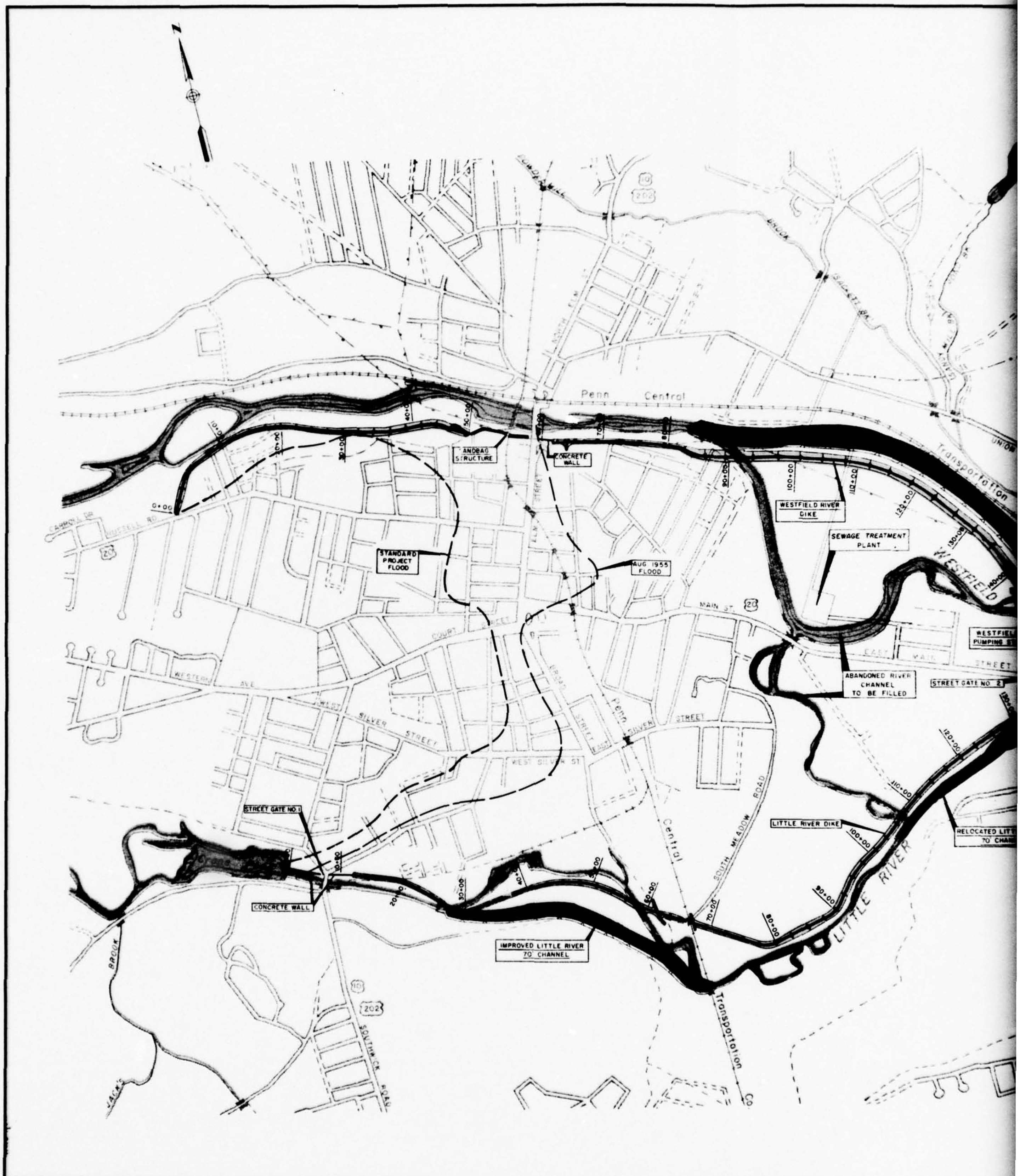
TABLE E-5 (Continued)

| | Impact Codes | PLAN NO. 1 Planning Area | PLAN NO. 1 Remainder of the Nation | PLAN NO. 7 Planning Area | PLAN NO. 7 Remainder of the Nation | PLAN NO. 8 Planning Area | PLAN NO. 8 Remainder of the Nation |
|---|---|---|---|---|---|---|---|
| (4) <u>REGIONAL DEVELOPMENT (RD)</u> | | | | | | | |
| A. TAXES AND LOCAL GOVERNMENT EXPENDITURES | | | | | | | |
| Reduces municipal expenditures for flood fighting and repair of flood damaged utilities | 3+,6,9 | Yes. Prevents flood damages to the SPF event. | | Yes. More area protected than Plan 1. | | Yes. More area protected than Plan 1. | |
| Increases property values, business activity and tax revenues. | 2+,6,9 | Yes. Allows for commercial and other growth. | | Yes, more than Plan 1. | | Yes, more than Plan 1. | |
| B. DESIRABLE COMMUNITY AND RECREATIONAL GROWTH | | | | | | | |
| Increases Industrial Activity | 1,6,9 | Yes. Provides incentives to locate in the protected area. | Yes. Increases the GNP. | Yes. More than Plan 1. | Same as Plan 1. | Yes, more than Plan 1. | Same as Plan 1. |
| Provides potential for increased recreational use | 2,6,10 | Yes. Potential is there, actual use depends on the city's desires | | Same as Plan 1. | | Same as Plan 1. | |
| C. EMPLOYMENT | | | | | | | |
| Increases employment during plan implementation | 1,6,9 | Yes. Hiring of construction workers and others. | May cause some reduction in nationwide unemployment. | Yes. More than Plan 1. | Same as Plan 1. | Yes. More than Plan 1. | Same as Plan 1. |

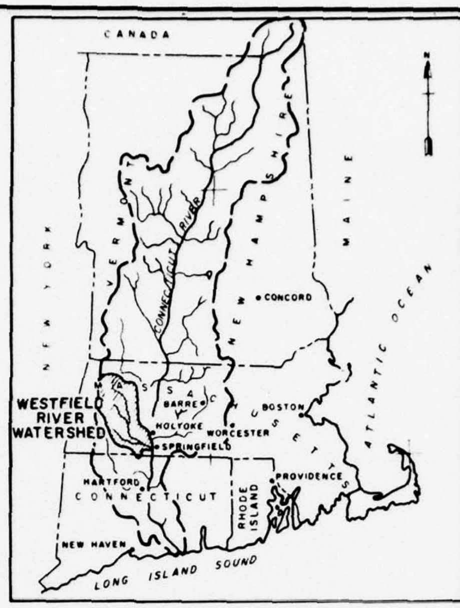
TABLE E-5 (Continued)

| | | PLAN NO. 1 | | PLAN NO. 7 | | PLAN NO. 8 | |
|---|---|---|---|---|---|---|---|
| | Impact Codes | Planning Area | Remainder of the Nation | Planning Area | Remainder of the Nation | Planning Area | Remainder of the Nation |
| Continuous employment during and after flooding | 3+,6,9 | Yes. Residential, commercial and industrial areas protected, as are most roads. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |
| D. DISPLACEMENT OF FARMS | | | | | | | |
| Displaces farms | 1,6,9 | Yes. Edge of some farm land will be taken for dike. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |
| E. INCOME | | | | | | | |
| Increases the net income to the area from expenditures by construction workers. | 1,6,9 | Yes. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |
| Provides a market for construction materials. | 1,6,9 | Yes. Increases output of goods and services. | | Yes. More than Plan 1. | | Yes. More than Plan 1. | |

1


N
Penn Central
Transportation
SANDBAG STRUCTURE
CONCRETE WALL
WESTFIELD RIVER DIKE
SEWAGE TREATMENT PLANT
STANDARD PROJECT FLOOD
AUG 1955 FLOOD
RUSSELL RD
MAIN ST.
COURT STREET
WESTERN AVE
WEST SILVER STREET
WEST SILVER ST
SILVER STREET
SOUTH MEADOW ROAD
ABANDONED RIVER CHANNEL TO BE FILLED
STREET GATE NO. 2
STREET GATE NO. 1
CONCRETE WALL
IMPROVED LITTLE RIVER 70' CHANNEL
LITTLE RIVER DIKE
LITTLE RIVER
Central
Transportation
SOUTHWICK ROAD
BROOK
WESTFIELD

2




## REGIONAL MAP

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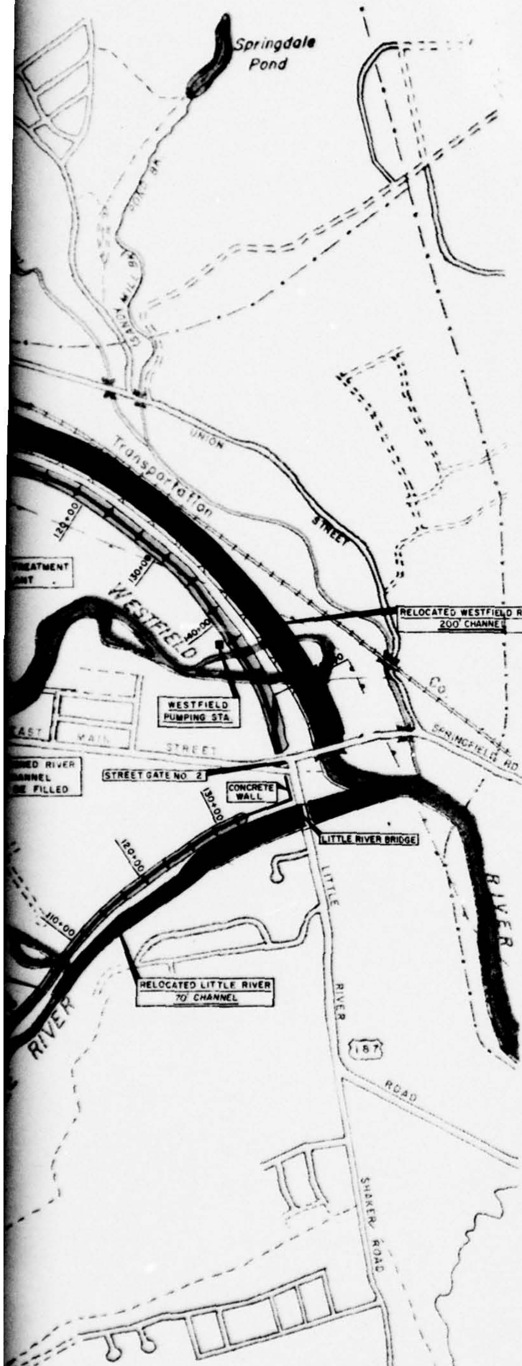
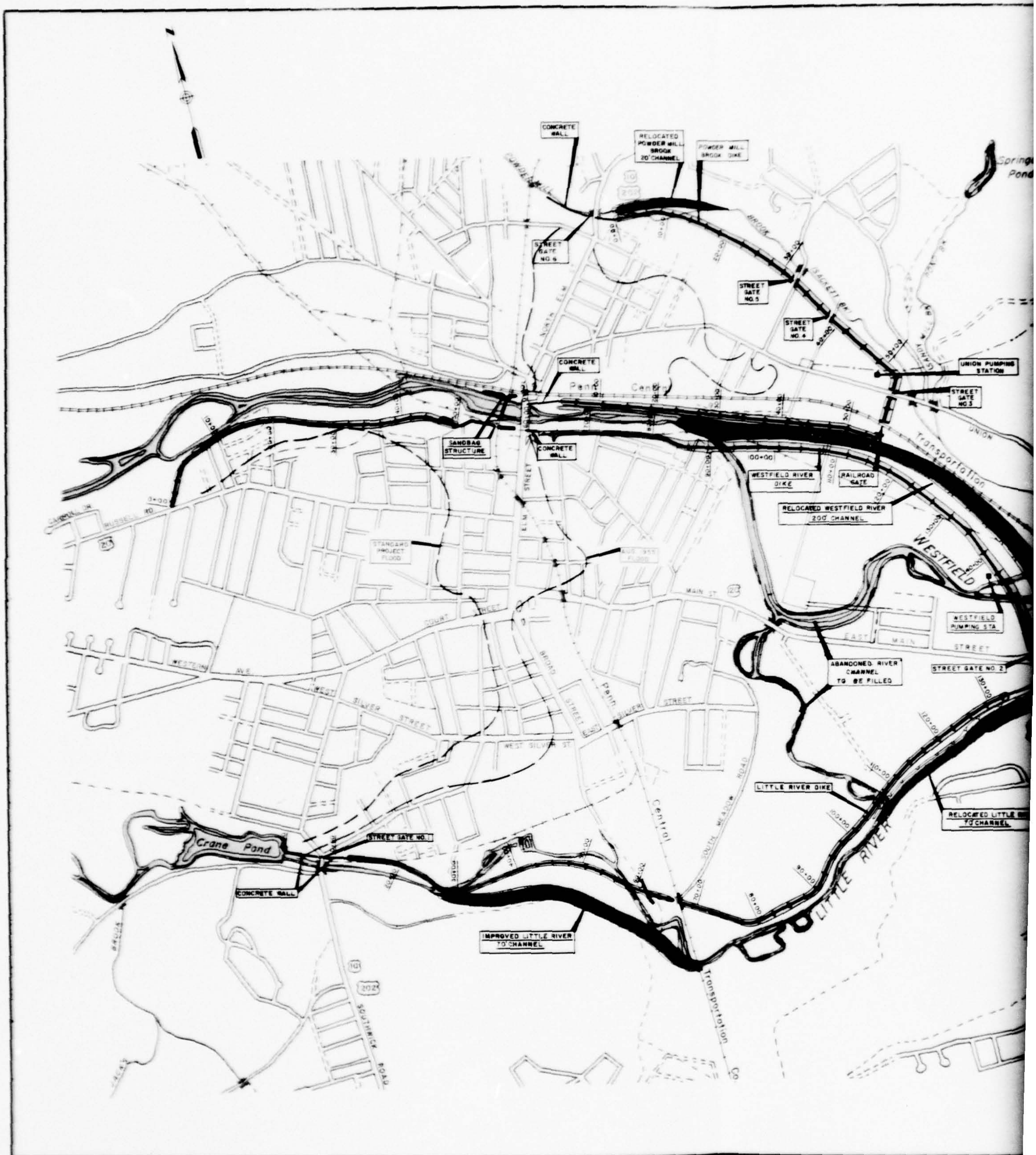



**WESTFIELD LOCAL PROTECTION**

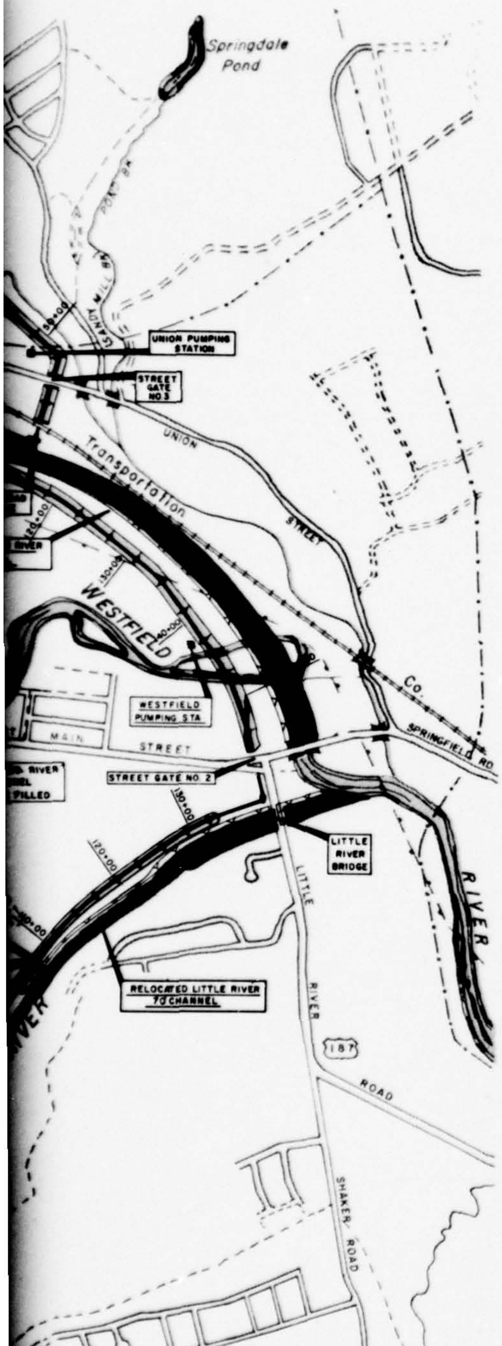
PLAN I

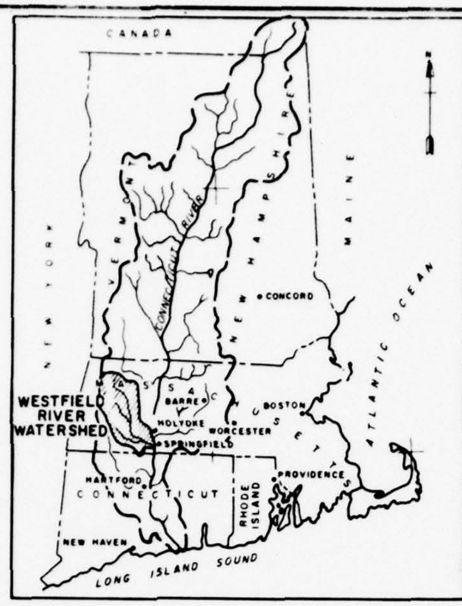
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

**PLATE E-1**


CONCRETE WALL
RELOCATED POWDER MILL BROOK 20' CHANNEL
POWDER MILL BROOK DIKE
STREET GATE NO. 6
STREET GATE NO. 5
STREET GATE NO. 4
UNION PUMPING STATION
STREET GATE NO. 3
CONCRETE WALL
SANDBAG STRUCTURE
CONCRETE WALL
WESTFIELD RIVER DIKE
RAILROAD GATE
RELOCATED WESTFIELD RIVER 200' CHANNEL
STANDARD PROJECT FLOOD
AUG. 1955 FLOOD
WESTFIELD PUMPING STA.
ABANDONED RIVER CHANNEL TO BE FILLED
STREET GATE NO. 2
LITTLE RIVER DIKE
STREET GATE NO. 1
CONCRETE WALL
IMPROVED LITTLE RIVER 70' CHANNEL
Crane Pond
WESTFIELD
LITTLE RIVER
MAIN ST.
EAST MAIN STREET
COURT STREET
WESTERN AVE.
WEST SILVER STREET
WEST SILVER ST.
SILVER STREET
BROAD STREET
ELM STREET
NORTH ELM
SOUTH MEADOW ROAD
SOUTHWICK ROAD
RUSSELL RD
Penn Central
Penn Central
Transportation
UNION
BROOK

2




## REGIONAL MAP

SCALE
10 0 10 20 30 40 50 MI.

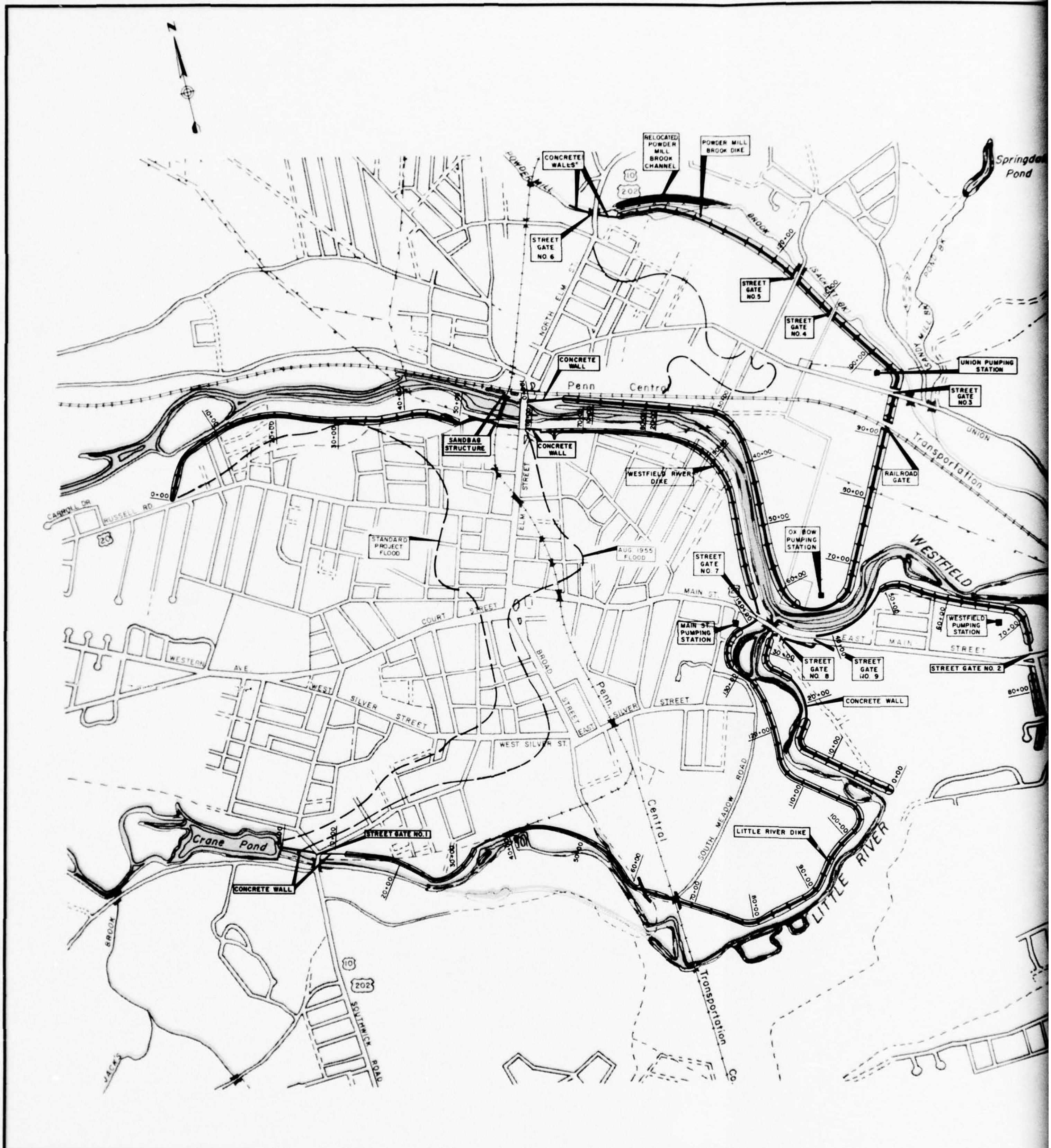
## WESTFIELD LOCAL PROTECTION

PLAN 2

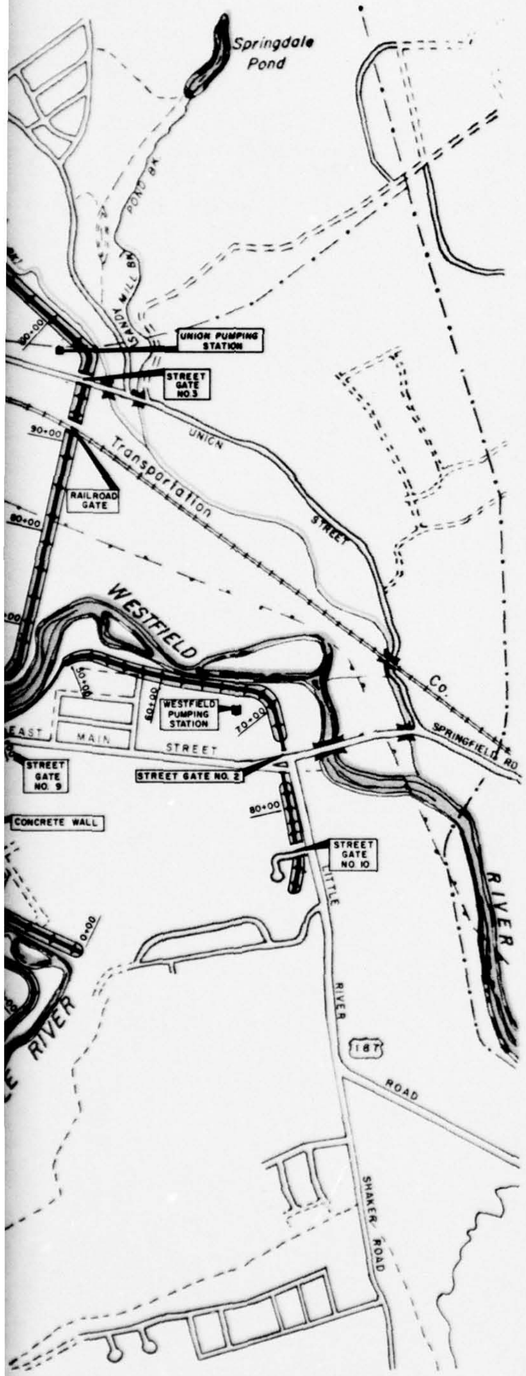
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

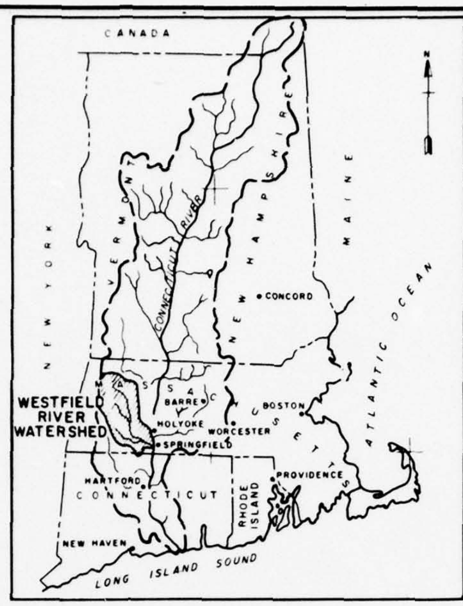
**PLATE E-2**

/


N
Springdale Pond
POWDER MILL
CONCRETE WALLS
RELOCATED POWDER MILL BROOK CHANNEL
POWDER MILL BROOK DIKE
BROOK
STREET GATE NO. 6
STREET GATE NO. 5
STREET GATE NO. 4
SANDY MILL BR
POND BR
NORTH ELM ST.
CONCRETE WALL
UNION PUMPING STATION
STREET GATE NO. 3
Penn Central
UNION
Transportation
RAILROAD GATE
SANDBAG STRUCTURE
CONCRETE WALL
WESTFIELD RIVER DIKE
OX BOW PUMPING STATION
WESTFIELD
CARROLL DR
RUSSELL RD.
ELM STREET
STANDARD PROJECT FLOOD
AUG. 1955 FLOOD
STREET GATE NO. 7
MAIN ST.
MAIN ST. PUMPING STATION
WESTFIELD PUMPING STATION
EAST MAIN STREET
STREET GATE NO. 8
STREET GATE NO. 9
STREET GATE NO. 2
COURT STREET
WESTERN AVE
BROAD STREET
WEST SILVER STREET
EAST SILVER STREET
Penn. Central
CONCRETE WALL
WEST SILVER ST.
SOUTH MEADOW ROAD
LITTLE RIVER DIKE
LITTLE RIVER
Crane Pond
STREET GATE NO. 1
CONCRETE WALL
BROOK
JACKS
SOUTHWICK ROAD
Transportation Co.

2




REGIONAL MAP

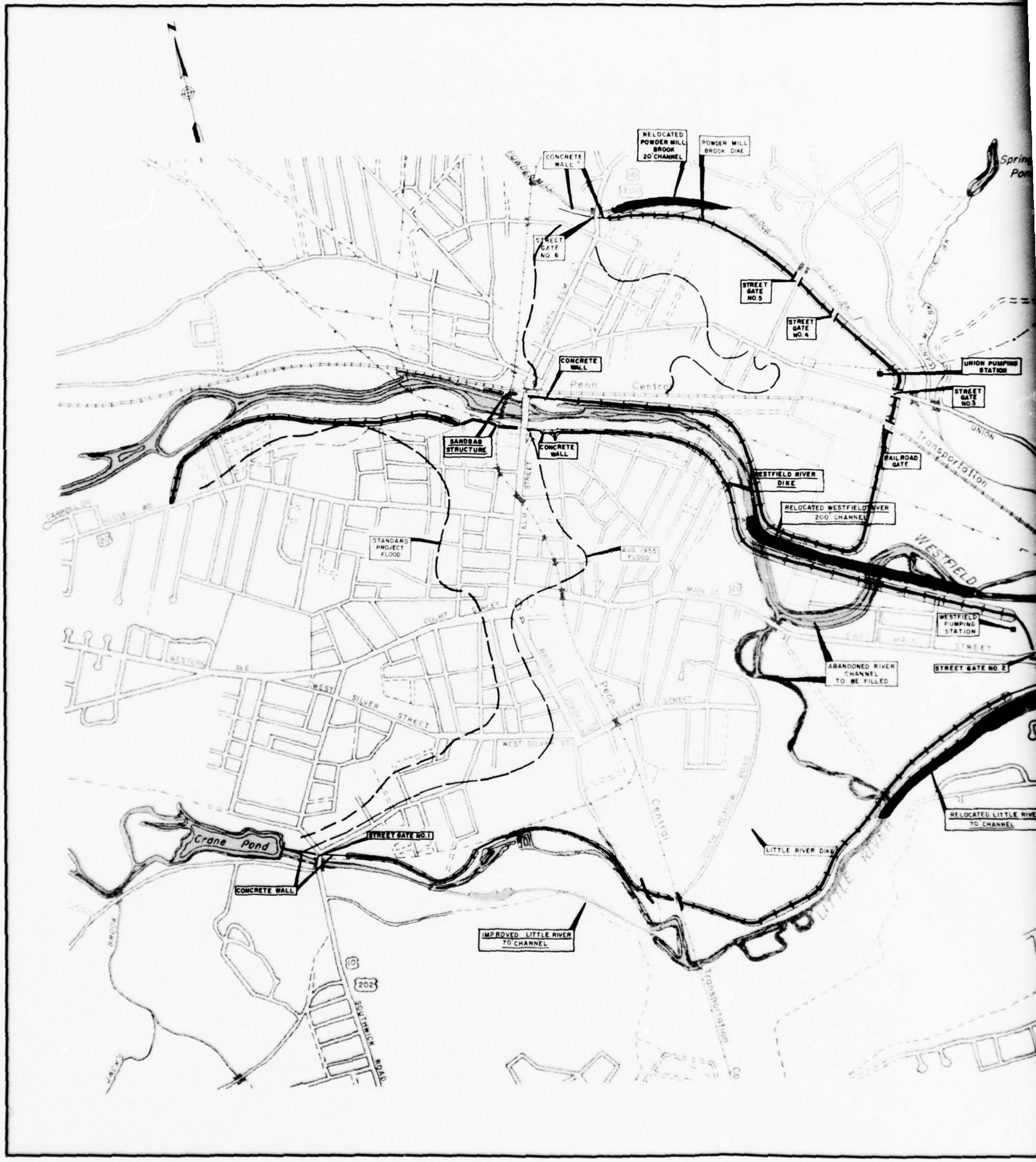
SCALE
10 0 10 20 30 40 50 MI.

**WESTFIELD LOCAL PROTECTION**

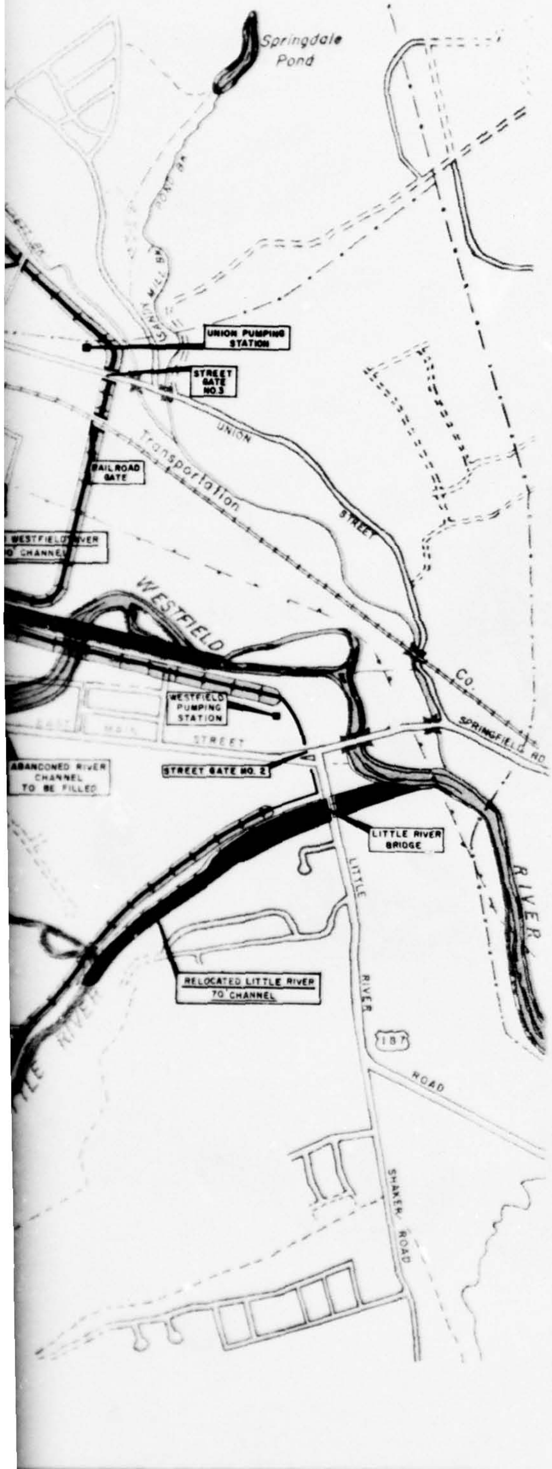
PLAN 3

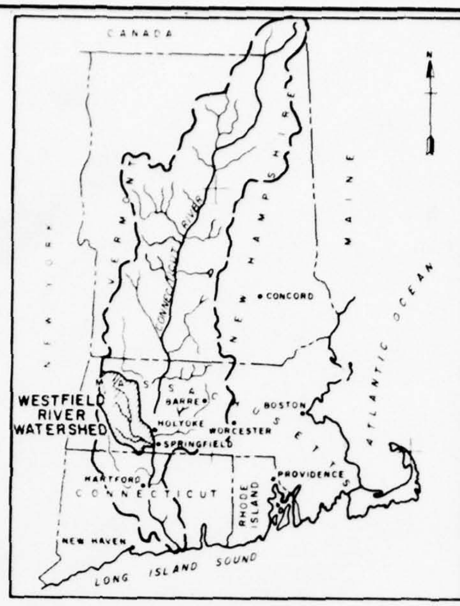
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

**PLATE E-3**



RELOCATED POWDER MILL BROOK 20' CHANNEL
POWDER MILL BROOK DIKE
CONCRETE WALL
STREET GATE NO. 6
STREET GATE NO. 5
STREET GATE NO. 4
UNION PUMPING STATION
STREET GATE NO. 3
CONCRETE WALL
Penn Central
SANDBAG STRUCTURE
CONCRETE WALL
RAILROAD GATE
WESTFIELD RIVER DIKE
RELOCATED WESTFIELD RIVER 200' CHANNEL
Transportation
WESTFIELD
STANDARD PROJECT FLOOD
AUG 1955 FLOOD
WESTFIELD PUMPING STATION
ABANDONED RIVER CHANNEL TO BE FILLED
STREET GATE NO. 2
RELOCATED LITTLE RIVER 70' CHANNEL
LITTLE RIVER DIKE
LITTLE RIVER
Crane Pond
STREET GATE NO. 1
CONCRETE WALL
IMPROVED LITTLE RIVER 70' CHANNEL
Penn Central Transportation Co
COURT STREET
MAIN ST
EAST MAIN STREET
WESTERN AVE
WEST SILVER STREET
WEST SILVER ST.
SILVER STREET
ELM STREET
BROAD STREET
RUSSELL RD
SOUTHWICK ROAD
SOUTH MEADOW ROAD




REGIONAL MAP

SCALE
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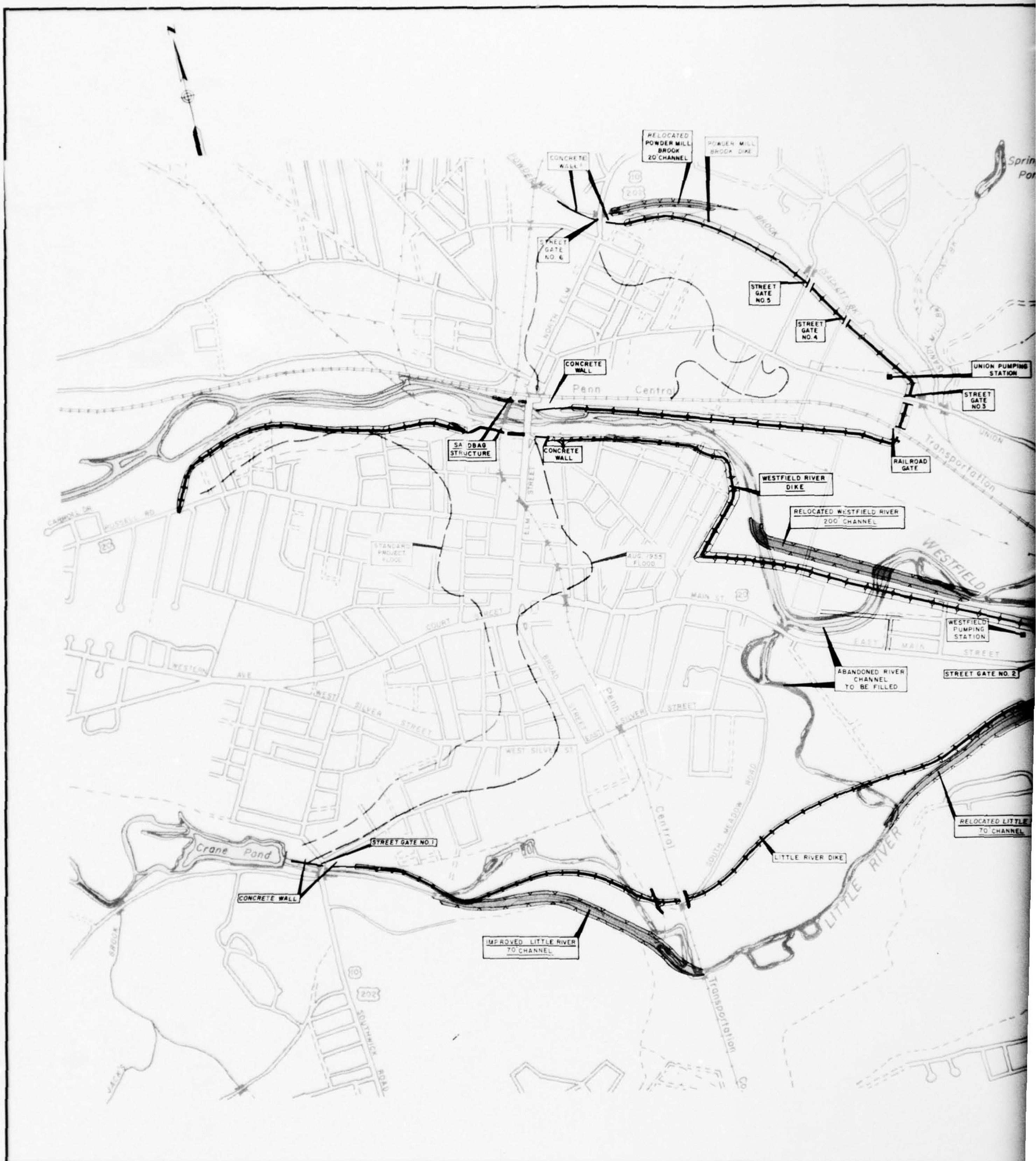
WESTFIELD LOCAL PROTECTION

PLAN 4

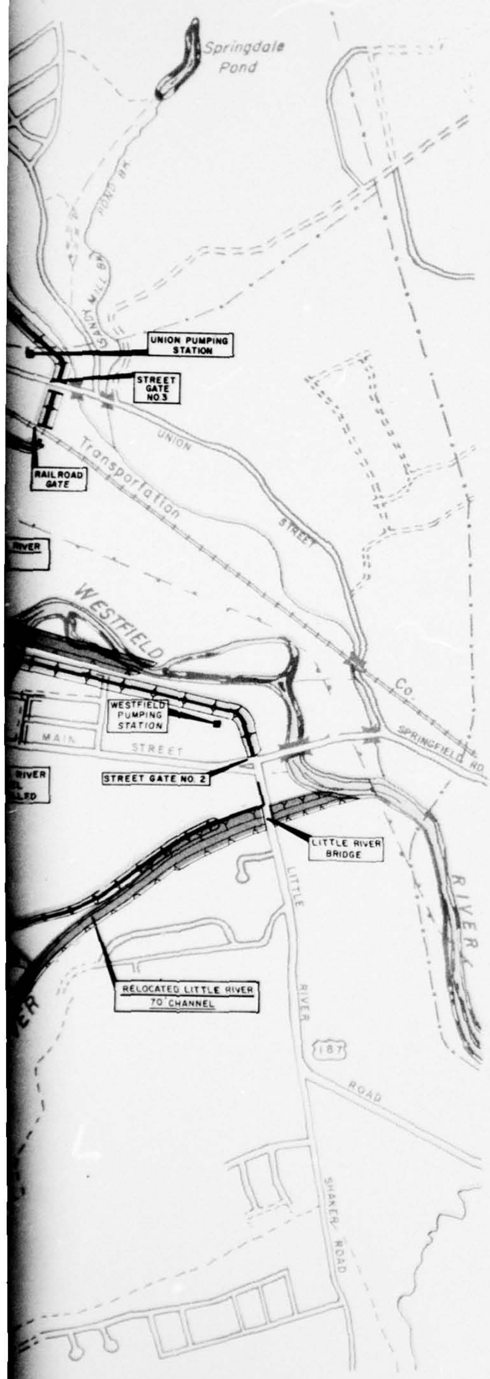
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

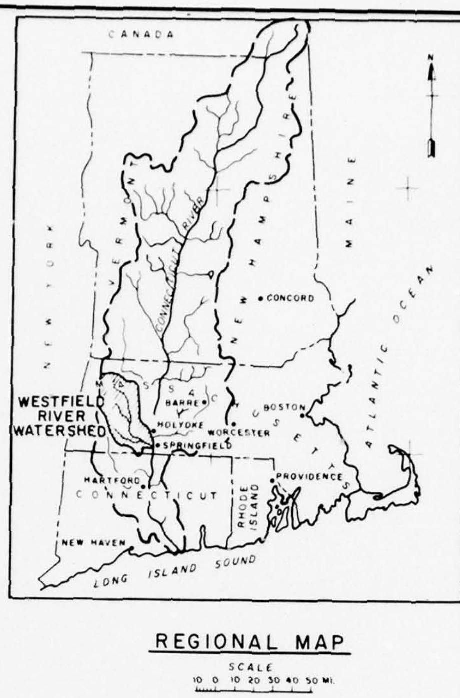
PLATE E-4



RELOCATED POWDER MILL BROOK 20' CHANNEL
POWDER MILL BROOK DIKE
CONCRETE WALL
STREET GATE NO. 6
STREET GATE NO. 5
STREET GATE NO. 4
UNION PUMPING STATION
STREET GATE NO 3
CONCRETE WALL
Penn Central
SANDBAG STRUCTURE
CONCRETE WALL
RAILROAD GATE
Transportation
WESTFIELD RIVER DIKE
RELOCATED WESTFIELD RIVER 200' CHANNEL
WESTFIELD
STANDARD PROJECT FLOOD
AUG. 1955 FLOOD
MAIN ST.
COURT STREET
WESTERN AVE
EAST MAIN STREET
WESTFIELD PUMPING STATION
STREET GATE NO. 2
ABANDONED RIVER CHANNEL TO BE FILLED
WEST SILVER STREET
RELOCATED LITTLE
70' CHANNEL
LITTLE RIVER DIKE
LITTLE RIVER
Crane Pond
STREET GATE NO. 1
CONCRETE WALL
IMPROVED LITTLE RIVER 70' CHANNEL
Penn Central Transportation Co.
SOUTHWICK ROAD

2



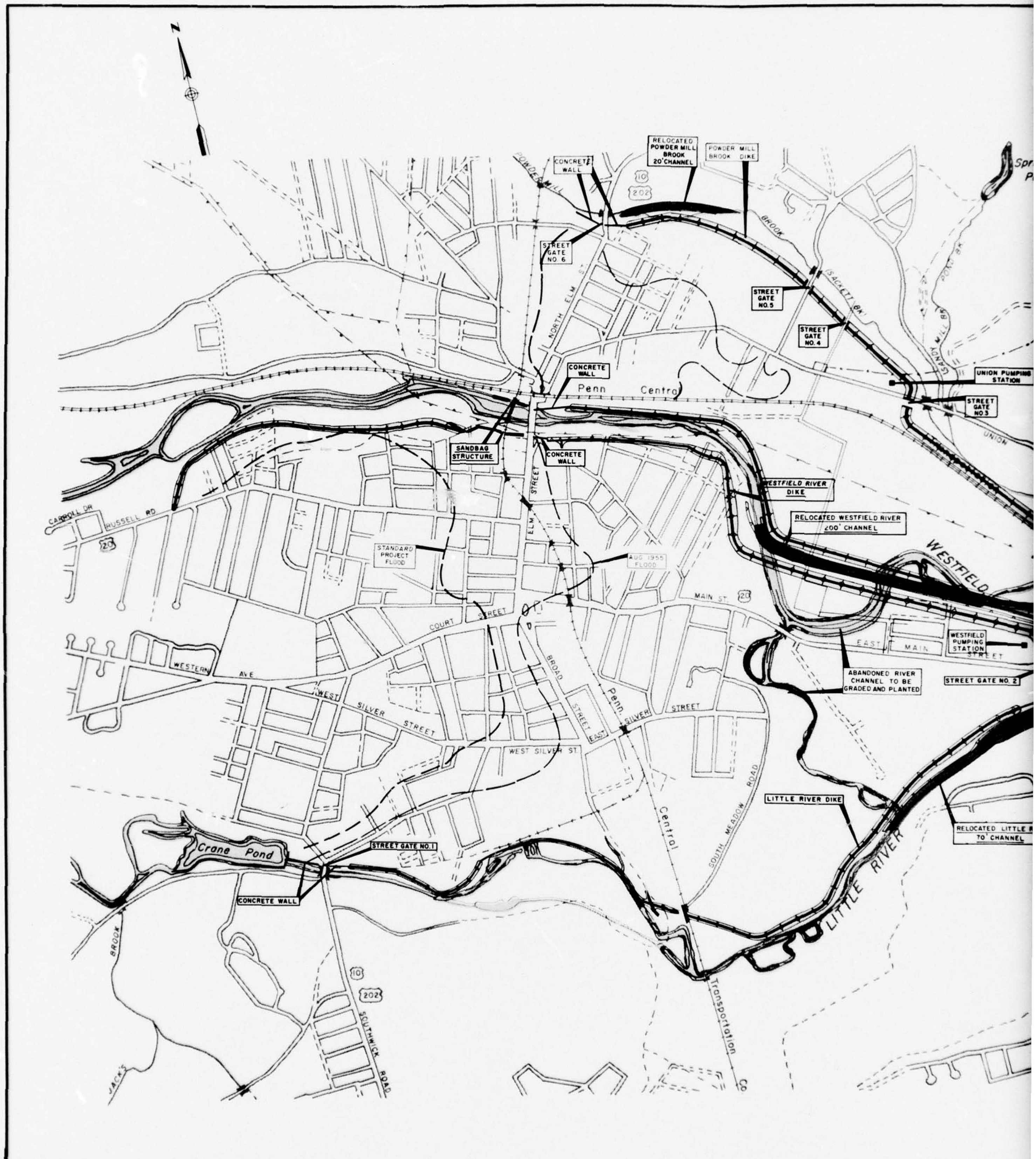

REGIONAL MAP

WESTFIELD LOCAL PROTECTION

PLAN 5

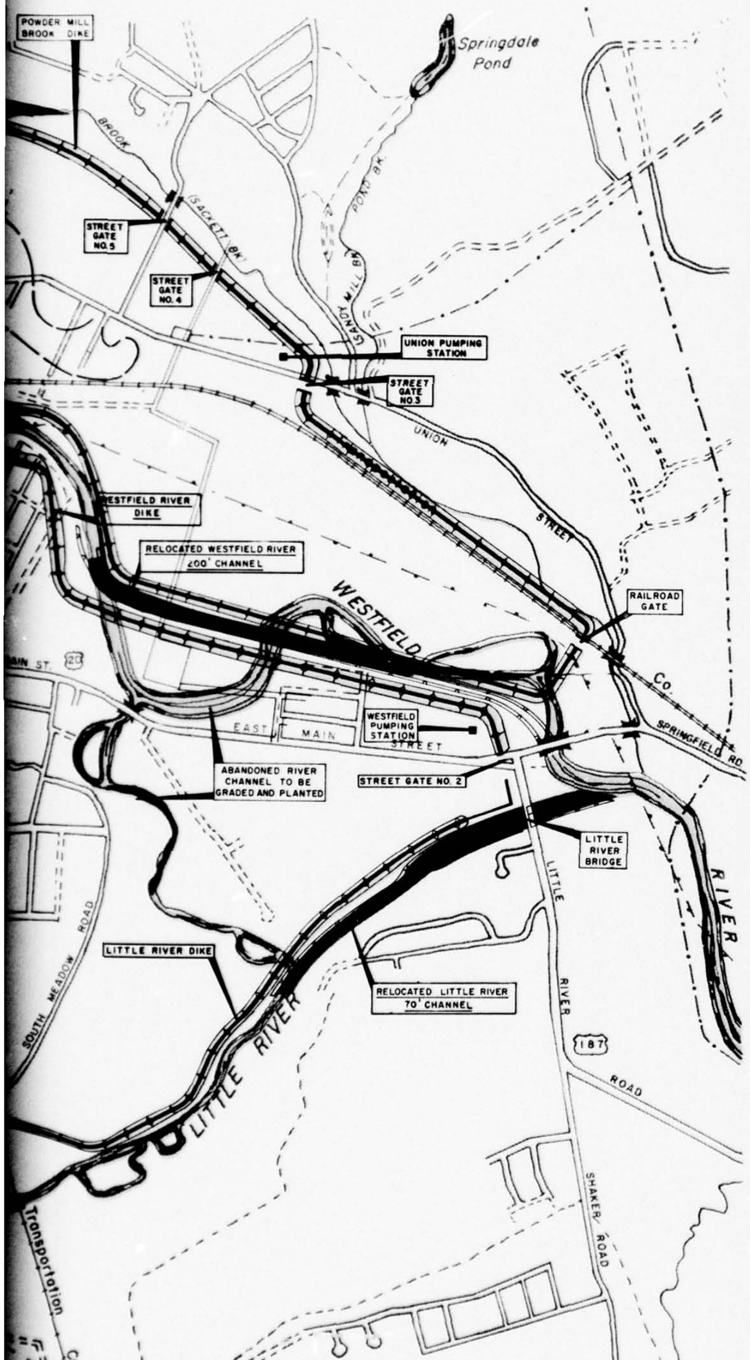
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

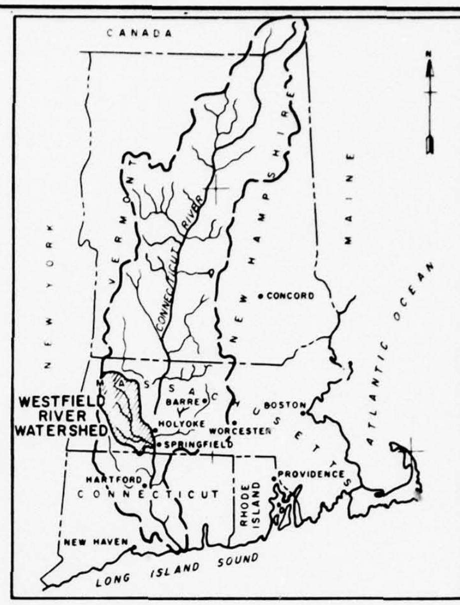
PLATE E-5



N
RELOCATED POWDER MILL BROOK 20' CHANNEL
POWDER MILL BROOK DIKE
CONCRETE WALL
POWDER MILL
STREET GATE NO. 6
NORTH ELM ST.
BROOK
SACKETT BK
STREET GATE NO.5
STREET GATE NO. 4
SANDY MILL BR.
POND BK
UNION PUMPING STATION
STREET GATE NO.3
UNION
CONCRETE WALL
Penn Central
SANDBAG STRUCTURE
CONCRETE WALL
WESTFIELD RIVER DIKE
RELOCATED WESTFIELD RIVER 200' CHANNEL
WESTFIELD
CARROLL DR.
RUSSELL RD
20
STANDARD PROJECT FLOOD
AUG 1955 FLOOD
ELM STREET
MAIN ST.
20
COURT STREET
WESTFIELD PUMPING STATION
EAST MAIN STREET
WESTERN AVE
ABANDONED RIVER CHANNEL TO BE GRADED AND PLANTED
STREET GATE NO. 2
WEST SILVER STREET
BROAD STREET
Penn
EAST SILVER STREET
WEST SILVER ST.
SOUTH MEADOW ROAD
Central
LITTLE RIVER DIKE
RELOCATED LITTLE R 70' CHANNEL
Crane Pond
STREET GATE NO.1
CONCRETE WALL
LITTLE RIVER
BROOK
10
202
SOUTHWICK ROAD
Transportation
JACK'S

2




REGIONAL MAP

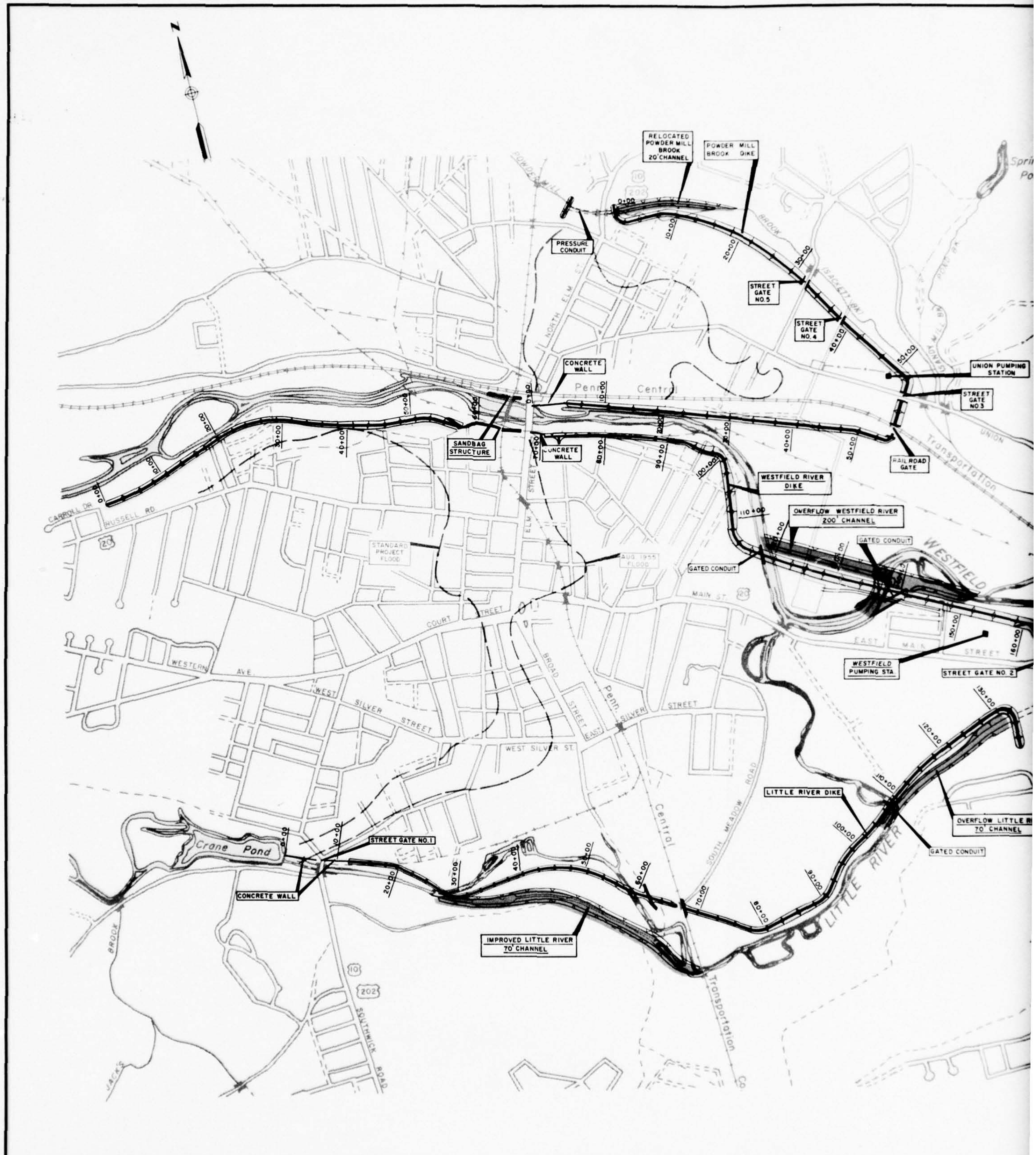
SCALE
10 0 10 20 30 40 50 MI.

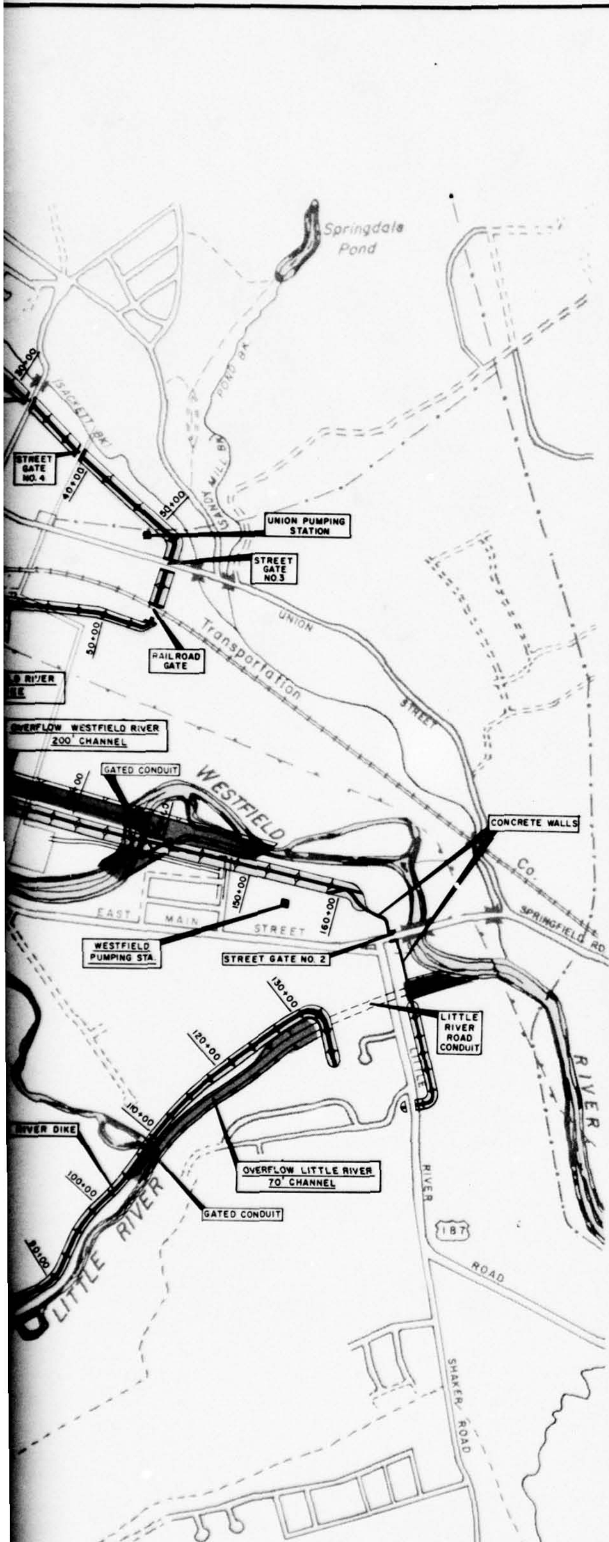
**WESTFIELD LOCAL PROTECTION**

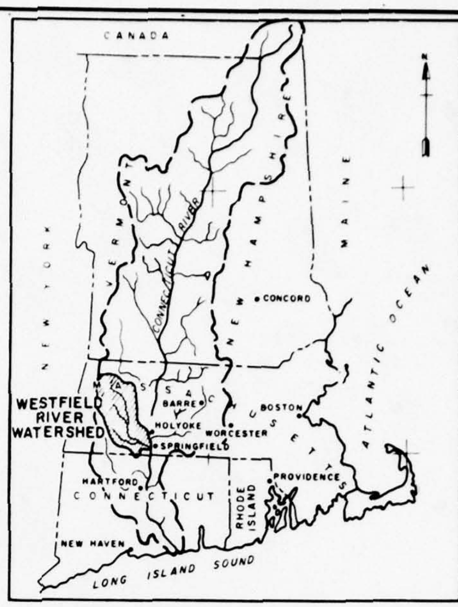
PLAN 6

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

**PLATE E-6**


N
RELOCATED POWDER MILL BROOK 20' CHANNEL
POWDER MILL BROOK DIKE
PRESSURE CONDUIT
STREET GATE NO.5
STREET GATE NO.4
UNION PUMPING STATION
STREET GATE NO.3
RAILROAD GATE
CONCRETE WALL
SANDBAG STRUCTURE
CONCRETE WALL
WESTFIELD RIVER DIKE
OVERFLOW WESTFIELD RIVER 200' CHANNEL
GATED CONDUIT
GATED CONDUIT
STANDARD PROJECT FLOOD
AUG. 1955 FLOOD
WESTFIELD PUMPING STA.
STREET GATE NO. 2
LITTLE RIVER DIKE
GATED CONDUIT
STREET GATE NO.1
CONCRETE WALL
IMPROVED LITTLE RIVER 70' CHANNEL
Penn Central
Penn. Central Transportation
UNION Transportation
WESTFIELD
LITTLE RIVER
Crane Pond
CARROLL DR.
RUSSELL RD.
WESTERN AVE.
COURT STREET
MAIN ST.
EAST MAIN STREET
WEST SILVER STREET
WEST SILVER ST.
EAST SILVER STREET
BROAD STREET
ELM STREET
NORTH ELM ST.
SOUTH MEADOW ROAD
SOUTHWICK ROAD
JACKS BROOK
BROOK
ISACKETT WAY
10
202
20




REGIONAL MAP

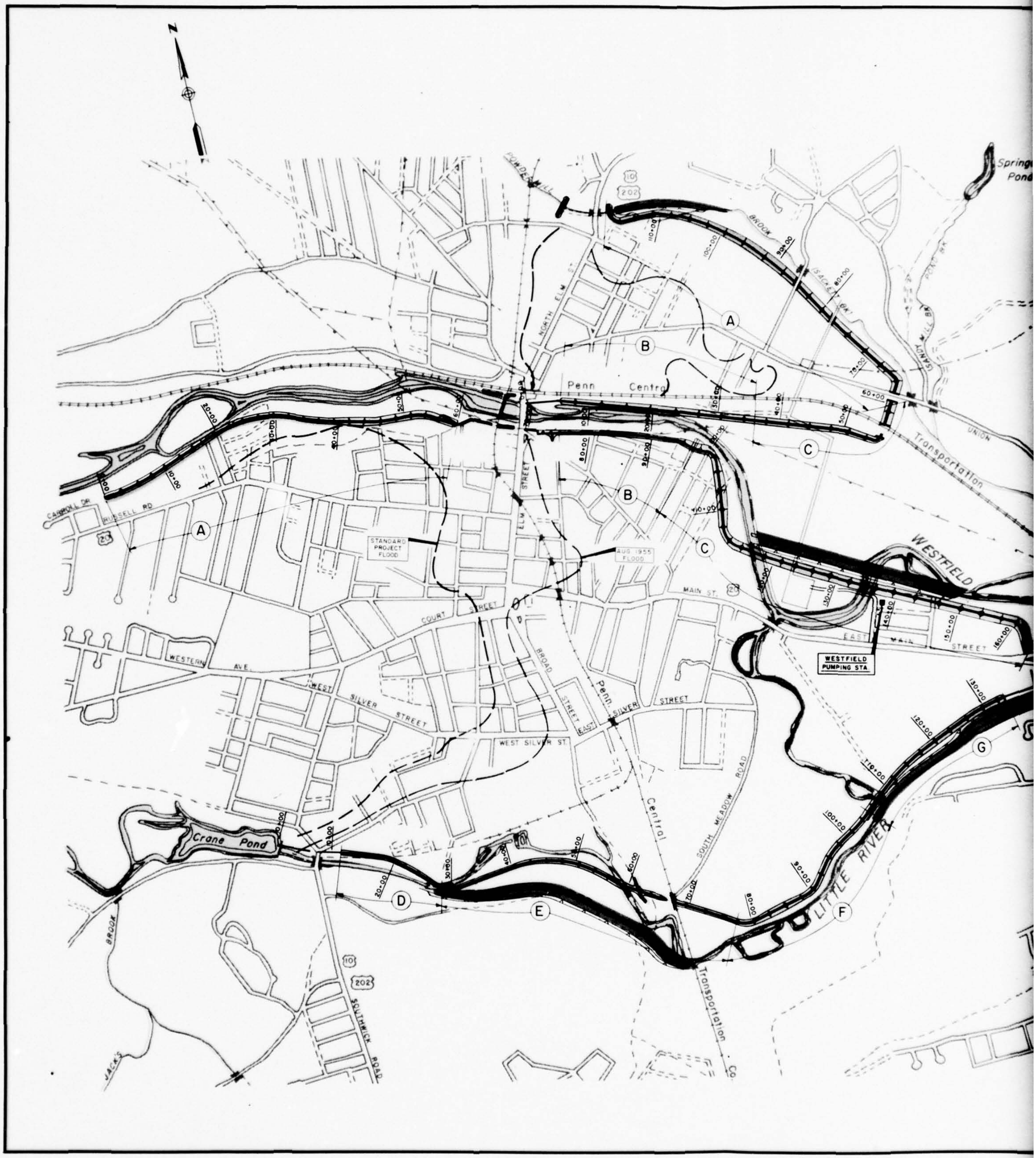
SCALE
10 0 10 20 30 40 50 MI.

**WESTFIELD LOCAL PROTECTION**

PLAN 7

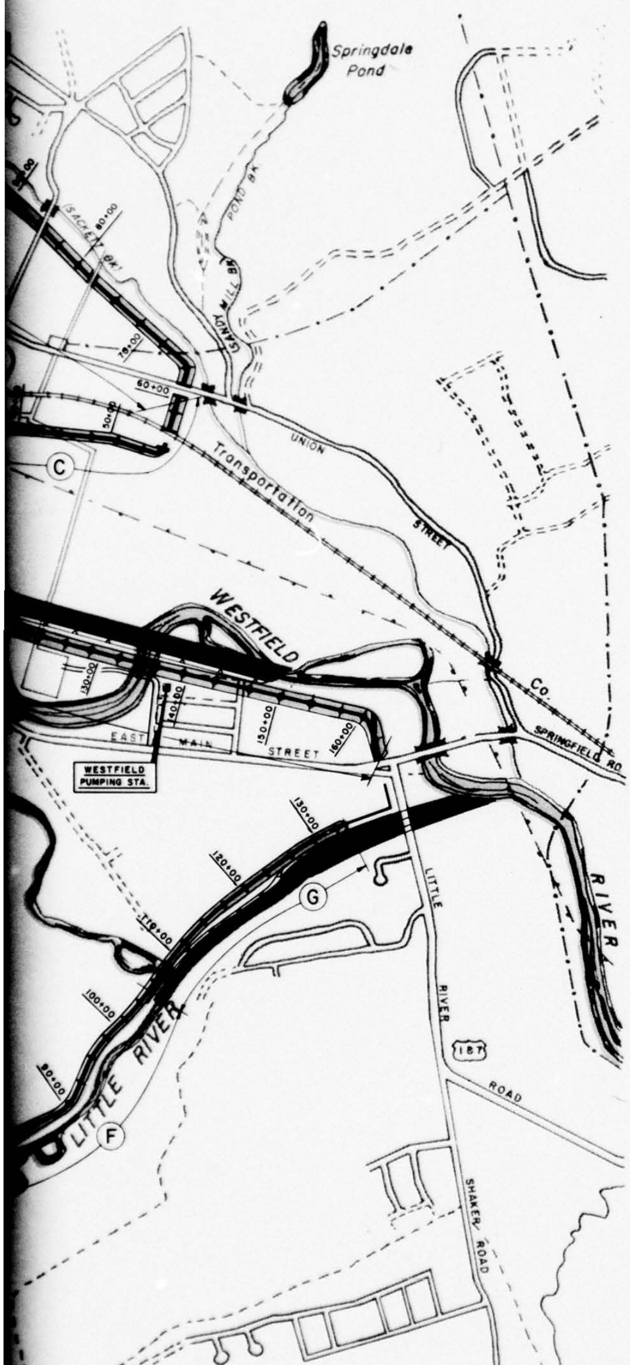
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

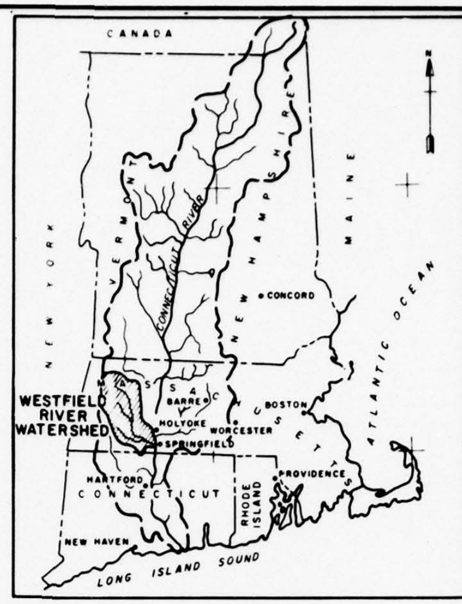
**PLATE E-7**



N
Springer Pond
POWDER MILL
10
202
NORTH ELM ST.
BROOK
ISAACS BK.
SANDY HILL BK.
POND BK.
A
B
C
D
E
F
G
Penn Central Transportation
UNION
CARROLL DR.
RUSSELL RD.
20
STANDARD PROJECT FLOOD
AUG 1955 FLOOD
ELM STREET
WESTFIELD
MAIN ST.
EAST MAIN STREET
WESTFIELD PUMPING STA.
COURT STREET
WESTERN AVE.
WEST SILVER STREET
BROAD STREET
EAST SILVER STREET
WEST SILVER ST.
SOUTH MEADOW ROAD
Crane Pond
LITTLE RIVER
BROOK
JACK'S
SOUTHWICK ROAD

2




REGIONAL MAP

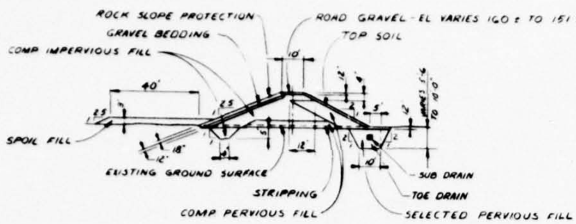
SCALE
10 0 10 20 30 40 50 MI.

WESTFIELD LOCAL PROTECTION

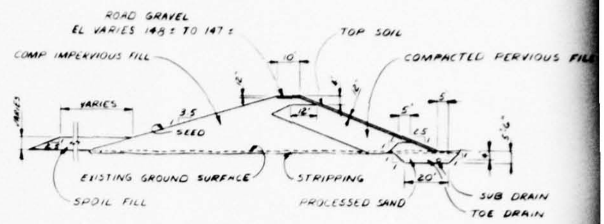
PLAN 8

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

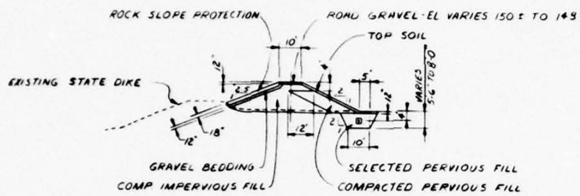
PLATE E-8




SECTION A




SECTION C

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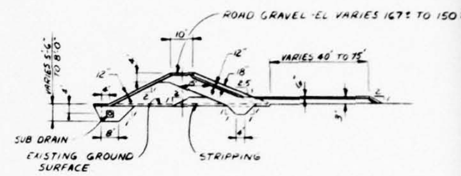
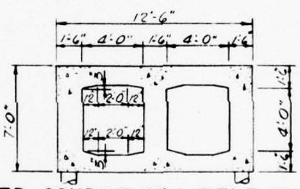
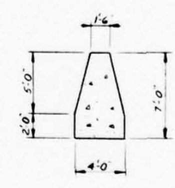



SECTION D, E & H



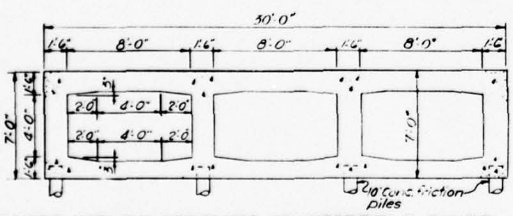

GATED CONDUIT AT LITTLE RIVER

SCALE 1/4" = 1'-0"



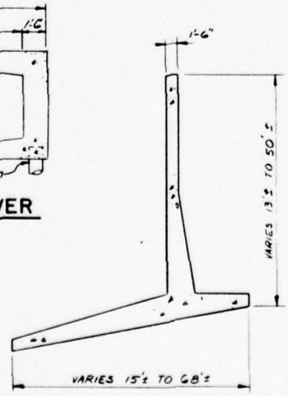

TYPICAL SILL

SCALE 1" = 5'-0"



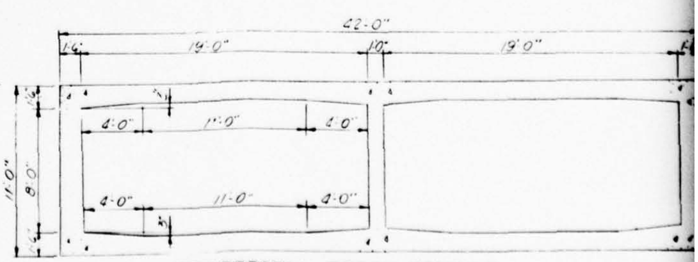

GATED INFLOW CONDUITS AT WESTFIELD RIVER

SCALE 1/4" = 1'-0"



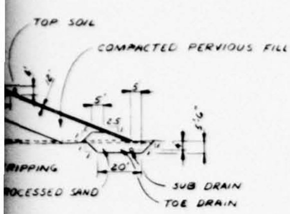

TYPICAL TEE WALL

NO SCALE




POWDERMILL BROOK CONDUIT

SCALE 1/4" = 1'-0"

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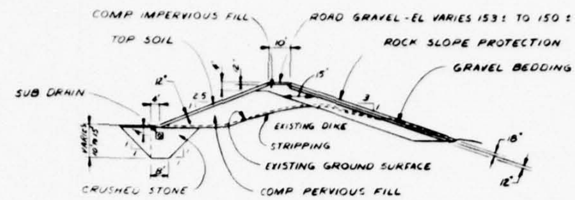
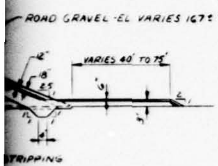
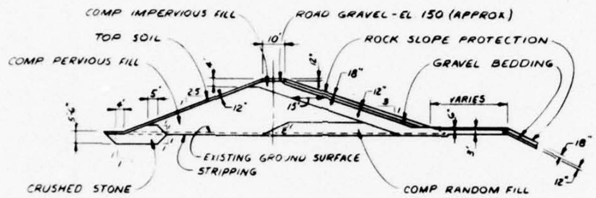


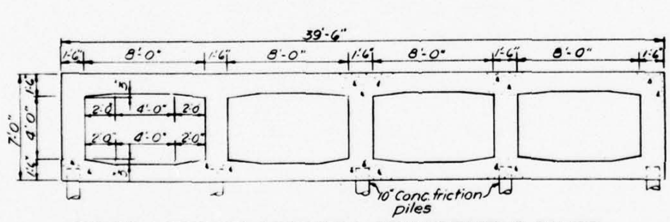

SECTION F




E & H



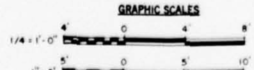

SECTION G




GATED OUTFLOW CONDUITS AT WESTFIELD RIVER

SCALE 1/4" = 1'-0"


CONDUIT




WATER RESOURCES FEASIBILITY REPORT

WESTFIELD LOCAL PROTECTION

PLAN AND TYPICAL SECTIONS

WESTFIELD & LITTLE RIVERS MASSACHUSETTS

# SECTION F

## THE SELECTED PLAN

SECTION F

# THE SELECTED PLAN

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# SECTION F

# THE SELECTED PLAN

In this section Plan No. 8, chosen as the selected plan in Section E, is described, and its effects, both favorable and unfavorable, are presented. Information concerning its design, construction, and operation and maintenance is given to provide a general understanding of the technical aspects of the plan. Cost, flood damage prevention and benefit information for the selected plan is presented in Section G.

## PLAN DESCRIPTION

### FUNCTIONAL ELEMENTS

The selected plan for preventing flooding to the highly urbanized portion of the Westfield flood plain provides for the construction of two protective loops, each consisting of earth dikes, concrete walls, overflow channels, street gates, a railroad gate, pumping stations, concrete conduits, temporary ponding areas, and various appurtenant structures. These dike systems which are shown on Plate F-1 would prevent flood waters from inundating most of the developed areas when the streams overflow their banks.

The earth dikes would have a total length of approximately 39,000 feet: 14,300 feet along the right bank of the Westfield River and its overflow channel, 12,000 feet along the left bank of the Westfield River and the right bank of Powdermill Brook, and 12,700 feet along the left bank of the Little River and its overflow channel. Three new channels would be excavated. A length of Powdermill Brook just downstream of North Elm Street would be re-routed into a new 1600-foot channel to eliminate two sharp bends in the present channel. A new 2500-foot channel across the oxbow of the Westfield River would be used as an overflow channel to carry river flows in excess of twice the annual flow, as would a new 4,000-foot Little River overflow channel.

Powdermill Brook would enter a 850-foot long concrete pressure conduit upstream of the Sterling Radiator Company building; it would then flow under North Elm Street back into its channel. An earth dike would be built on the right bank of this channel. Street gates would be installed where the dike system crosses Union Street and three other roadways. A flood gate would also be required across the Penn Central railroad tracks. Interior drainage would be handled by the Union Street pumping station, located at the easterly end of the protected area.

The selected plan would provide protection for about one-half of the 3100 acre flood plain in the study area and approximately 98 percent of the buildings in this flood plain. Flooding along Powdermill Brook would no longer affect some 300 acres of land in the Union Street area lying between the brook and the Penn Central railroad tracks, as this part of the flood plain is protected by the smaller of the two dike systems.

Flooding in about 1400 acres of flood plain lying generally between the Westfield and Little Rivers, and Little River Road would be prevented by the larger of the two dike systems. One feature of this system is the three gated conduits placed in the dike to allow the two rivers to continue to flow in their existing channels. Coordination with local interests indicated a strong desire to keep the rivers flowing where they now exist, for environmental, social and cultural reasons. Accordingly, two gated conduits would be installed in the oxbow of the Westfield River, one above and one below the junction with the Little River. The third gated conduit would be installed where the Little River passes through the dike and turns sharply north to the junction at the oxbow of the Westfield River. These gated conduits would remain open allowing normal river flows to continue within the existing river channels. A concrete control sill at the entrance to each overflow channel would be designed to allow flows in excess of twice the average annual flow to pass through the overflow channels. This would occur several times each year. The three gated conduits would not be closed during these routine events and water would flow in the existing channels. On infrequent occasions when the water level approaches the top of bank in the existing river channels, the gated conduit would be throttled down or closed entirely, keeping flows in the Westfield and Little Rivers entirely outside of the protected area. As soon as interior runoff begins to fill up the reaches of the interior channels, the Westfield pumping station would pump this accumulated runoff over the dike to the overflow channel.

LANDS, RELOCATIONS AND MITIGATIONS

In order to build the local protection project, about 129 acres of land would be required for temporary construction easements. The

overall construction period for the entire project is expected to last for three years. However, construction easements on any given piece of property are scheduled to last for only one year, as work in any particular location would not exceed a year. A total of 228 acres would be provided by the city for the permanent easement required to build the project.

The major item of relocation is an estimated $635,000 for the installation of a highway bridge where the new Little River overflow channel crosses Little River Road (Route 187).

Relocation of gas, water and other utility lines would cost an estimated $115,000, and repaving or replacing sidewalks and sections of roads would cost an estimated $150,000. An 18-inch sewer main which extends along the Westfield River from the No. Elm Street bridge to the sewage treatment plant would be relocated. Since much of it is along the same alignment as the proposed dike, relocation of this force main will be necessary, at an estimated cost of $300,000.

Mitigation procedures that would result from constructon of the project are in two categories. The first is the reduction of the impact caused by the increase in flood stages outside of the protected area, and the second is the reduction of the impact on the numerous archaelogical sites which may occur from construction of the dike systems. Installation of the two dike systems would, by preventing the flood waters from spreading over the entire flood plain, cause an increase in standard project flood stages of about two feet at the "narrows", a natural channel constriction on the Westfield River at the city boundary with West Springfield. This effect on Westfield River stages would gradually decrease to zero at the Agawam bridge in West Springfield, several miles downstream of the "narrows". Approximately 75 residential, commercial, or industrial buildings are situated within the affected reach of river outside the dikes downstream to the Agawam bridge. Also effected would be lengths of the railroad, Route 20 and other streets. In addition, the level of protection afforded by a 3800 foot section of the Corps' West Springfield Dike would be reduced. The effected length of dike extends from the Agawam bridge to the upstream end of the project.

Several techniques of mitigation, both structural and non-structural, could be used in combination to minimize the effect of increased flood stages resulting from installation of the project. Some of the structural actions could include:

a. Installation of dikes or walls around groups of buildings.
b. Remove and/or relocate buildings, roads and railroads.
c. Raise roads and first floor elevations of buildings.
d. Flood proof structures.

# *EVALUATED ACCOMPLISHMENTS*

Construction of the selected plan would result in the protection of approximately 1700 acres of the flood plain in the study area. Included in this protection are more than 2200 residential units, 400 commercial establishments, 30 public buildings, and about 40 significant industrial activities. Most of the unprotected 1400 acres is agricultural or open land, but there are approximately 20 residential and commercial activities along Union Street and Route 20 within the city of Westfield that would remain subject to flooding.

The August 1955 flood caused $8,000,000 in damages. The same event today would cause about $100,000,000 in damages; the increase would be due partly to inflation and to the considerable commercial development along Route 20. The residential and commercial growth in other parts of the flood plain would also contribute increased damages. Construction of the local protection project would permit most of the routine activities of the city to continue during periods of flooding. After the flood the amount of clean-up and repair would be minimal.

During the 100-year life of the project, the savings to the public are estimated at $3,781,000 annually.

The beneficiaries of the protection afforded by this project include the several thousand people who live and work in the highly urbanized flood plain. The other residents of the city would also benefit, since they would not have to bear the cost and inconvenience of clean-up and rebuilding after flood events.

The specific accomplishments as they affect the individual citizen of Westfield include:

a. Protection against loss of life.
b. Protection against private property loss.
c. Protection against loss of public property.
d. Protection against discontinuity of industrial and commercial activity which could result in loss of income and economic security.
e. Protection against discontinuity of the community's educational process.
f. Protection of the health and safety of the citizens.
g. Would provide recreational facilities for the public.

The result would be an increase in the social and economic well-being of the citizens of Westfield and the surrounding communities.

## EFFECT ON THE ENVIRONMENT

In order to determine the impacts from the dikes and other associated structures of the selected plan, coordination was initiated with a number of Federal, State and local agencies. The joint effort resulted in the identification of nine impacts, of which two were considered as being significant and seven were considered as being less than significant.

## SIGNIFICANT IMPACT I

If the project is constructed the area currently available for temporary flood water storage would be significantly reduced. Consequently, those areas outside of and adjacent to the dikes, as well as those areas downstream, would be inundated by increased flood stages which would result in significantly greater damages to those areas.

For an occurance of the design flood event, with the project in place, there would be a three-foot rise in flood stages upstream of the U.S.G.S. gaging station. Downstream of the gage, the rise would be approximately two feet, and gradually diminish to normal stages at the Agawam Bridge in West Springfield. There are approximately 7 homes and 23 businesses that would be impacted outside the project between Westfield and Agawam Bridge. Under the worst conditions the expected increase in damages to the properties would be about $12,700.

As discussed previously in this section the city of West Springfield would also experience increased flood stages under project conditions.

## *SIGNIFICANT IMPACT II*

To construct the proposed dikes, approximately 3.1 million cubic yards of fill would be needed. Three types of materials would be used for the dikes: (1) an impervious clay for the core; (2) pervious sand and gravel for covering the core; and, (3) riprap for protecting certain areas where erosion might occur. The movement of this material in the city could cause some adverse impacts; these include: (1) disrupting traffic; (2) increasing dust, noise, and carbon monoxide levels; and, (3) the possible destruction of certain roads. In the following paragraph, these problems will be discussed.

Table F-1 displays the amounts of the different types of materials needed to construct the dikes and the number of trips necessary to move the material. These are approximate figures, as are the other figures in this section. There could be a substantial variance above and below the numbers presented.

TABLE F-1

CONSTRUCTION MATERIAL TRIPS

| Material | Cubic Yards | Estimated Round Trips |
|---|---|---|
| Clay | 2,000,000 | 100,000 |
| Sand & gravel | 840,000 | 42,000 |
| Riprap | 217,000 | 10,850 |

The clay would be excavated from a new borrow pit located between Fowler and Sackett Roads, near the Southwick town line.

Approximately 100,000 round trips would be required to transport the clay. It is presently planned to use Sackett and Fowler Roads as one-way streets for hauling; consequently, about 50,000 trips would move over these roads. The entire 100,000 trips would move along City View Road and onto South Maple. At this juncture, approximately 87,200 trips would be diverted to an access road that would parallel the proposed dike along the Little River. Access roads and temporary crossings over the Little River and Westfield River would be required. Approximately, 13,800 round trips would move along South Maple,

Pleasant Street, Elm Street and Franklin Street; the material from these trips would be used to construct the dike on the right bank or south side of the Westfield River above Elm Street. To build the downstream portions of the dikes, Mainline Drive and small portions of East Main Street and Little River Road would be used.

The construction of the dikes would require about three years; however, the roads used for hauling the clay would not be used continually during this time. It is anticipated that the dikes would be constructed in sections and that each section could be completed in less than one year.

Borrow sites for sand, gravel and material for the riprap have yet to be determined. Consequently, an exact truck route cannot be given for the hauling of these materials; but, to alleviate traffic congestion the dikes and access roads would be used as much as possible.

Dust, Noise, and Carbon Monoxide Emissions

Dust and noise would result from the moving of construction materials. To try and alleviate dust, the trucks could be showered with water as they leave the borrow and a covering could also be required over the load. This should eliminate most of the problem but if it becomes necessary, the streets can be swept to help reduce the amount of dirt on the road, thus reducing the amount of available particles for air pollution.

As for noise, all equipment would be required to meet all State and Federal standards for noise abatement. Although this would certainly not eliminate the problem, it should keep noise down to acceptable levels.

The use of diesel trucks may increase carbon monoxide levels in downtown Westfield. Presently, EPA does not have a monitoring program or standards for construction activities, but there are standards for certain facilities in operation.

EPA may require a monitoring program during construction if it is believed that air quality may be significantly reduced; and, of course, the Corps and its contractors would comply with any standards imposed.

At least three roads -- Fowler, Sackett, and City View -- are not designed for carrying heavy loads. Consequently, it is likely that sustained hauling over these roads would reduce them to unacceptable levels. The Corps' contractor, therefore, would be required to maintain the roads during hauling operations, and would be required to rebuild and resurface the roads to a level consistent with their use.

# *LESS THAN SIGNIFICANT IMPACTS*

IMPACT I

Storm water drainage from urban areas contain pollutants. Small reaches of the Little and Westfield Rivers would be closed off from the main channels during some floods. Storm runoff from a segment of the city within the dikes would flow into these interior channels of the rivers. With the direct urban runoff and the two combined storm sewers discharging into this section of the rivers, three potential impacts could occur:

1) Some aquatic organisms could succumb due to the direct impact from pollutants;

2) The organic materials and chemicals in the drainage could reduce the supply of oxygen in the closed-off section of the rivers; and,

3) There could be a build-up of deposits in the river's interior channels.

Predicting the exact kill of organisms in the enclosed sections of the rivers would be difficult, if not impossible. It would primarily depend upon the concentration of the pollutants and upon the retention time of the flood waters.

Another possible impact would be the potential loss of dissolved oxygen due to decomposition of organic matter swept into the enclosed area. As organic material is decomposed by bacteria, dissolved oxygen is required; and if sufficient organic material is present, all of the dissolved oxygen could be consumed. Of course, any organism requiring dissolved oxygen would die if this should happen, and it would appear from preliminary analysis that this could happen. In addition, the potential exists for a possible build-up of debris and organic material within the closed sections of the Little and Westfield River. To guard against this, the project would be designed to allow more than three cfs of water through the natural channel during the spring freshets; this should be more than sufficient to keep the channel clear of any debris.

IMPACT II

A concern expressed by the Commonwealth Water Quality Agencies was that the proposed project might change the assimilative capacity (the ability of a stream to purify itself) of the Westfield River. Essentially four factors affect assimilative capacity: pollutants, water temperature, dissolved oxygen and flow time.

The Westfield project would change only one of these factors--flow time; the others would remain essentially the same with or without the project.

The Corps' hydrologic study found that the project would decrease flow time through the effected reach by one hour. A theoretical analysis revealed that a decrease of one hour would increase the Biochemical Oxygen Demand (BOD) by 0.2 mg/l. However, the experimental error for the test would be about 2 mg/l for organic loads found in the Westfield River; the change in the loading from the project would be inconsequential.

IMPACT III

Loss of natural terrestrial and aquatic wildlife habitat would be insignificant since the proposed project would impact only a small portion of the total habitat found in the Westfield River Basin. Changes in types of habitat would also occur. These impacts would be mitigated to the extent possible by planting the dikes and adjacent areas for wildlife. The impacts associated with the borrow area will also be mitigated by contouring and planting. For these reasons, the Corps believes the impact on wildlife habitat would likely be insignificant.

IMPACT IV

The Westfield project would change the erosional pattern of the streams. Those areas that would have increased erosion potential would be riprapped to protect the stream banks. Therefore, the impact due to erosion would be minimal.

IMPACTS V AND VI

If the project is constructed, there would be the potential for open land behind the dikes to be developed for industrial purposes and also for a loss of views of the rivers. The local citizen must decide if the trade-offs are worth the protection of the city.

IMPACT VII

Twenty-nine sites having cultural resources were found during a reconnaissance survey. Adverse impacts may occur to these sites during construction or operation of the projects. It may be possible to mitigate the impact through archaeological investigation and preservation.

## *OTHER EFFECTS*

The social impacts and indirect economic effects are generally intangible, but while they cannot be measured precisely they can be identified, described and to a certain extent can be ranked according to the degree of impact expected to result.

The construction of the dike system would have the usual construction and post-construction impacts which are generally temporary. Beneficial impacts include an increase in employment and resulting increase in commercial activity, while negative effects include an increase of truck traffic on local roads, and an increase in air and noise pollution. The increase in economic activity generally outweighs the negative effects of traffic congestion, and noise and air pollution.

After the three-year construction period, the post-construction phase begins and would last for the 100-year life of the project. the post-construction effects of any project should be compatible with the long-term policy of the affected cities. Westfield has a policy of controlled growth. The local protection project would be compatible with that policy, although the amount, type and rate of development is entirely up to the city.

The most immediate impact of the project would be in the area of Little River Road near Route 20. In order to construct the Little River overflow channel, the Woronoco Savings Bank, two homes on Towpath Lane, and two or three homes and garages on Little River Road would have to be removed. In addition, the concrete flood wall along the end of Little River Road would obstruct the Shop Rite shopping center.

The bank building could be relocated nearby and affected homeowners could purchase homes elsewhere without any direct economic loss since they would be paid fair market value plus relocation expenses. The Shop Rite center would be paid damages resulting from the installation of the flood wall. These direct values can be measured by standard appraisal practices. The social effect over the long term is not subject to such direct measurement, but is believed to be slightly negative for two reasons:

(1) The character of the immediate neighborhood will be changed from a comfortable residential-commercial community to a barren channel approximately 200 feet wide at the top of bank.

(2) The demarcation between the protected and unprotected areas will be abruptly defined by a concrete wall about twelve feet high. These effects are not considered major as the neighborhood is a transition area between commercial, residential and agricultural activities.

The most significant effect of the local protection project would be the flood protection offered by its construction. In addition to the protection of existing structures from flood damages, these would be the increase in the value of unoccupied land and many existing properties that could then be put to a higher economic use.

Since the August 1955 flood of record, about 500 apartment units have been built along Union Street, and three shopping centers have been built along East Main Street (Route 20). An application for a 24-acre shopping center, also on East Main Street, is pending. All of these are in the flood plain but will be protected if the project is built. Additional land now vacant, used for farming, or not meeting the current or future criteria for highest and best use will be subjected to pressure for development. This pressure for development in the flood plain has been strong, as evidenced by extensive growth in the last two decades. However, the construction of the project will protect much of the developable land, and accordingly will remove some restrictions to development.

The city will have to balance the desire for growth against the desire to maintain the character of the city because the use for commercial purposes is usually not compatible with the best use for environmental or social purposes. There are several citizen's groups actively working with various city agencies to determine and implement a policy of controlled growth.

# DESIGN

The Westfield Local Protection Project was designed to protect approximately 1700 acres of highly developed flood plain from flooding by the Westfield and Little Rivers, and Powdermill Brook. The project consists of two dike systems totalling more than 8-1/2 miles of compacted earth dike and concrete flood walls, along with ancillary structures such as street gates, pumping stations, etc., two overflow channels totalling 6500 feet, and 5400 feet of improved channel on the Little River. Gated conduits would be installed at two locations on the Westfield River and at one location on the Little River. At times of flooding, these gates will be shut, causing the rivers to flow through the overflow channels while the reaches of river channel inside the dike would be used to collect interior runoff and direct it to the pumping station.

The selected plan will be designed to protect against a design flood of 28,000 cfs on the Little River and 101,000 cfs at the Westfield gage on the Westfield River. The flow on the Westfield River represents the standard project flood modified by the existing Knightville and Littleville reservoirs. Since the interior drainage system will have to handle runoff from very flashy streams, the storage ponds and pumping stations will be designed for a 20-year frequency rainfall coincident with flood stages similar to those which would occur during a recurrence of the flood of August 1955 as modified by Knightville and Littleville reservoirs. Gravity outfalls from the temporary storage ponds will be designed for a 100-year frequency storm with concurrent normal river flow. A detailed description of the Hydrology and Hydraulic design is given in Section D of this Appendix.

FOUNDATIONS AND MATERIALS

Westfield is located in the Connecticut Valley lowland, which is underlain by Triassic sedimentary bedrock consisting of conglomerate, sandstone and shale with included sheets of igneous rock commonly referred to as "trap". Relief in the lowland is generally low and subdued except where faulting and differential weathering have left prominent ridges of the "trap" projecting above the softer sediments. The higher hills in the region are blanketed by glacial till. Extensive outwash and lake deposits laid down in late glacial and post glacial lakes occur in the lower parts of the region. These deposits form broad plains in the valley bottoms and wide, flat-topped, steep-faced terraces along the valley sides. Thin deposits of recent alluvium have accumulated on the broad flood plains in the valley bottoms.

Subsurface investigations in 1940, 1957, and 1962 provided information about foundation conditions and the character of material in the existing dike. Design studies indicated that the impervious material for the Little River dike must be obtained off-site.

The Westfield and Little Rivers flow in shallow channels along wide-flat valleys which meet in the low, broad plain on which the major part of the city of Westfield is located. Bedrock consisting of sandstone also outcrops in the Little River at and immediately downstream from the existing dam at Stevens Mill. Another small area of bedrock outcrop occurs along Union Street east of Powdermill Brook approximately 1200 feet north of Route 20. Elsewhere throughout the area bedrock is buried beneath extensive outwash and glacial lake deposits which floor the wide plain and form the prominent terraces which border the flat, low valleys of the Westfield and Little Rivers. The outwash at the surface, in large areas of the river plains, consists of silty fine sand. Locally, sandy silt occurs. Exposures on the faces of the terraces indicate that they are composed mainly of sand.

Overburden in the site area ranges from ten to over sixty feet in thickness and consist of stratified sand, silt and gravel. At the surface generally throughout the area surficial materials are underlain by a stratum of sandy gravel and gravelly sand which is generally about ten feet thick but varies in thickness locally and in a few limited areas is entirely missing. Beneath this stratum, silty fine to gravelly sand, clean sands, gravels, silt, occasionally clayey, extend to bedrock or to a thin deposit of till which overlies the bedrock in some areas. In local reaches of the Westfield River channel, the river has eroded the surficial fine sands and silts and exposed the underlying gravels. Similar conditions occur locally along the Little River. Locally along both rivers, old natural depressions have been filled with variable materials including, in part, cinders, ashes, bricks, lumber and other trash. Water levels, as indicated by short-term readings, are generally at or slightly above adjacent river levels. Existing dikes along the Westfield and Little Rivers are constructed generally of silty fine sand with occasional thin zones of sandy gravel.

Bedrock throughout the site area is pink to red-brown, calcareous, thick-bedded sandstone. It is generally coarse grained and includes conglomerate zones, but locally, fine-grained and even shaly phases occur. The attitude of the bedding is obscure because contacts between beds are largely gradational. Observations of outcrops in the vicinity of the site, however, indicate that the dip of the sandstone is eastward at relatively gentle angles. Bedrock is moderately to deeply buried throughout most of the site area. Near the upstream end of the proposed excavation for the Westfield diversion channel, however,

bedrock was encountered in borings at a depth of 6 feet below proposed channel grade and it is possible that rock may be encountered in excavations in this reach. Bedrock outcrops extensively in the Little River at Stevens Mill and is available for foundations for the proposed concrete flood wall at depths ranging from 5 to 25 feet.

STRUCTURAL

The selected plan would provide for the construction of earth dikes, overflow channels, street gates, a railroad gate, sandbag structure, pumping stations, a pressure conduit, gated conduits, ungated conduits, and other appurtenant structures.

Each of these structural units will be designed in accordance with the most recent design criteria established by the Office of the Chief of Engineers. The design will be in accordance with the procedures established in the published and improved document "Design Memorandum No. 5 - Embankments and Foundations", "Design Memorandum No. 6 - Pumping Station", and "Design Memorandum No. 7 - Detail Design, Walls and Miscellaneous Structures".

RECREATION

The project could be used as the basis for a major recreation plan by the city. Various potential activities have been discussed with city officials and civic groups for the use of portions of the project for a variety of activities. The five ponding areas which are to be used for the temporary storage of interior runoff during project operations would be retained by the city as "green areas". These areas cannot have structures built on them but could be used for picnic grounds, softball fields, tennis courts or similar "non-structural" facilities.

The eight-mile length of the earth dike would be built with a roadway on top. Except for occasions when the project is in operation, this roadway could be used by the general public for walking, jogging, bicycling, rest areas, and vista areas. Motocycles, snowmobiles and other motorized recreation vehicles would be prohibited because of the possibility of damage to the dike and the danger to others using the area.

At one or more locations along the length of the project an area could be made available on land between the dike and the river for picnic areas and/or a boat landing for canoes or small outboards. An approved means of access could be provided over the dike.

# CONSTRUCTION

The design of the project, including the preparation of plans and specifications, will require approximately three years from the time the project is authorized and funds are allocated. This schedule is contingent upon continuous annual funding of the project during the three-year design period. No unusual design problems are expected.

After the contract is awarded, the time required for construction of the project is estimated at three years. This schedule also is contingent upon continuous annual funding of the project during the three-year construction period. No significant problems are expected during construction.

Impervious fill material suitable for use in constructing the impervious section of part of the Westfield River dikes and the riverside berms in local reaches would be obtained from required channel excavation for the relocation of the Westfield River. For the dikes and berms along the Little River and Powdermill Brook and the remainder of the Westfield River dike, impervious fill material could be obtained from a new borrow pit located between Fowler and Sackett Roads, near the Southwick town line.

Materials taken from the required excavations that are of suitable quality for pervious and random fill will be used in the construction of the project. All other required fill material can be obtained from approved sources within 15 miles of the project site.

High grade traprock is available from commercial suppliers located in Westfield within a haul distance of less than five miles.

Since the amount of concrete needed for the project is small enough to be handled by existing commercial producers in the area, investigations will be limited to these producers.

# *OPERATION AND MAINTENANCE*

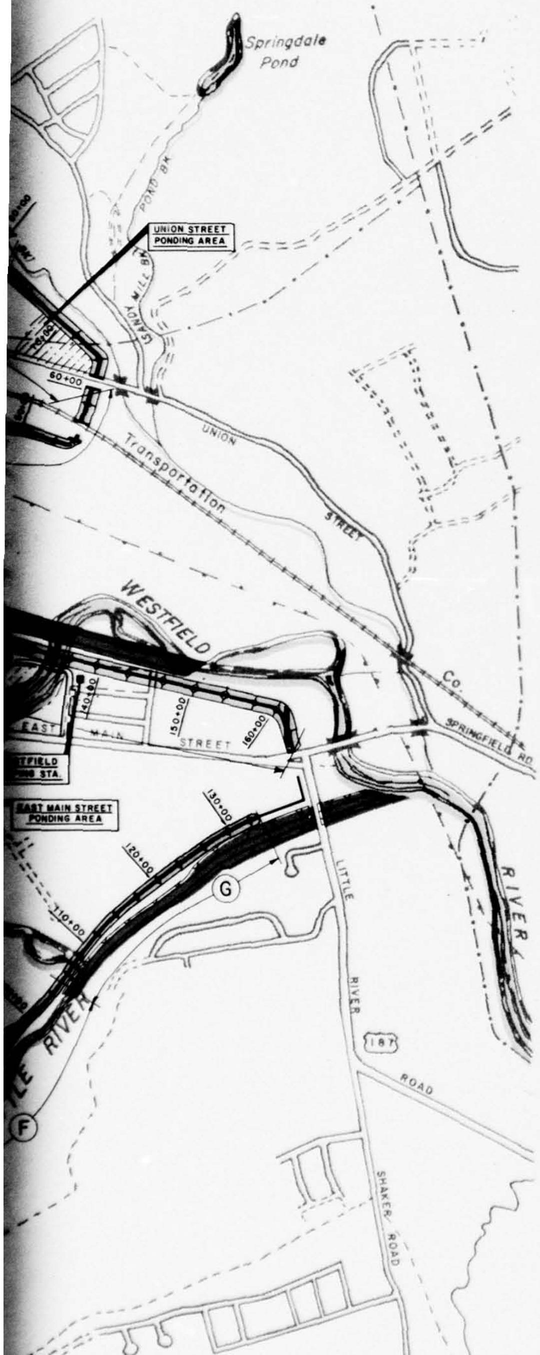
The operation of the project will consist essentially of a warning system, closure of the several gates and conduits, operation of the pumps, and continuous inspection during flood emergencies.

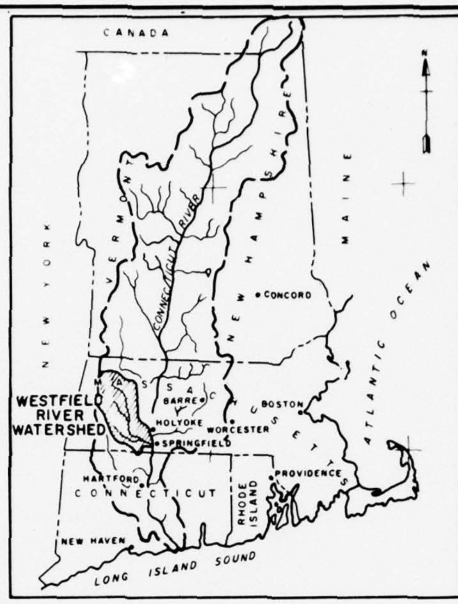
The very rapid runoff from the steep watershed upstream of the project area results in a relatively short warning time. Therefore, an adequate forecasting and warning system would have be implemented if the project is to be fully operational in time to protect against flooding. When a flood appears imminent, the street gates, railroad gate, and gated conduits would be closed. As the interior runoff accumulates within the protected area, the pumps would be operated and the runoff discharged outside the dikes. If the river stages continue to rise, the sandbag structure at the railroad bridge, which would be within the freeboard space would be installed. The final operational activity would be a constant patrol along the entire length of the project for continuous surveillance of the structures and all ancillary works.

Maintenance would consist of mowing the dikes at least twice a year, control of vegetation on slopes protected by riprap and within the new overflow channels. Concrete structures, gates and other components of the flood protection system would be inspected and repaired as necessary. At least once each year a simulated operation of all project features would be required. This would assure that an adequate number of personnel are properly trained for an actual flood event. It would also provide the opportunity to inspect all components and assess the need for maintenance or replacement.

The operation and maintenance of the project would be the responsibility of local interests and would be accomplished in accordance with Federal regulations. A project operation and maintenance manual would be prepared by the New England Division and distributed to the responsible parties.

N
UNION STREET PONDING AREA
SHEPARD STREET PONDING AREA
STANDARD PROJECT FLOOD
AUG 1955 FLOOD
WESTFIELD PUMPING STA
EAST MAIN STREET PONDING AREA
RIVER SIDE PONDING AREA
SOUTH MEADOW ROAD PONDING AREA
Penn Central
Penn Central Transportation
Transportation
UNION
WESTFIELD
LITTLE RIVER
Crane Pond
CARROLL DR.
NORTH ELM ST.
ELM STREET
COURT STREET
MAIN ST.
EAST MAIN STREET
WESTERN AVE.
WEST SILVER STREET
WEST SILVER ST.
SILVER STREET
BROAD STREET
SOUTH MEADOW ROAD
SOUTHWICK ROAD
BROOK
A
B
C
D
E
F
G




REGIONAL MAP

SCALE
10 0 10 20 30 40 50 MI.

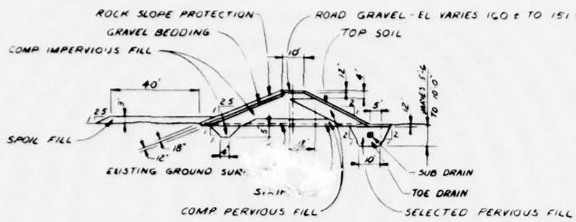
**WESTFIELD LOCAL PROTECTION**

SELECTED PLAN

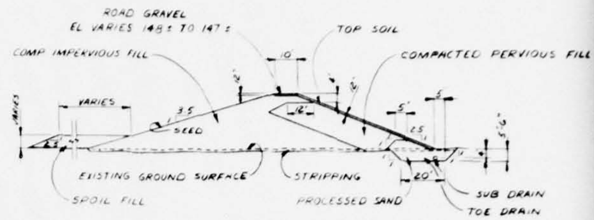
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

**PLATE F-1**

CORPS OF ENGINEERS




SECTION A

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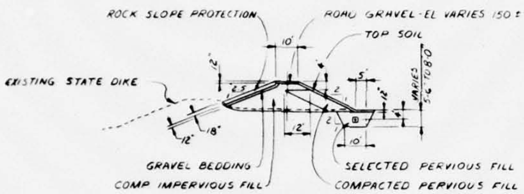


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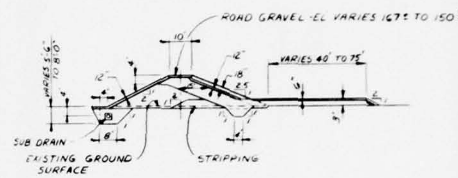
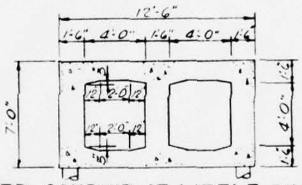


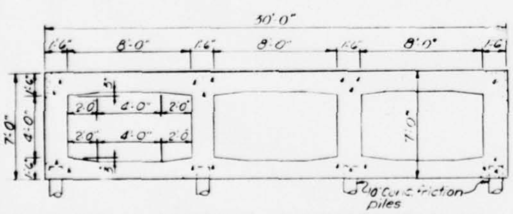

SECTION D, E & H

MATERIALS SAME AS SECTION



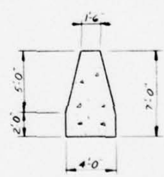

GATED CONDUIT AT LITTLE RIVER

SCALE 1/4" = 1'-0"



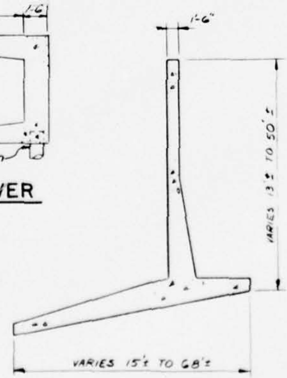

GATED INFLOW CONDUITS AT WESTFIELD RIVER

SCALE 1/4" = 1'-0"



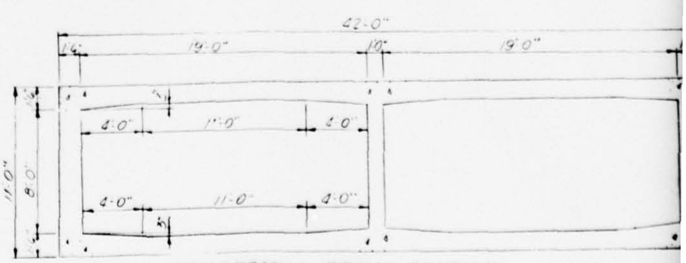

TYPICAL SILL

SCALE 1" = 5'-0"




TYPICAL TEE WALL

NO SCALE



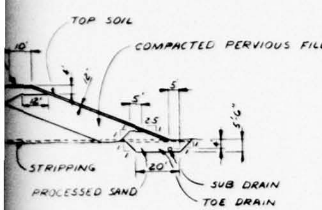

POWDERMILL BROOK CONDUIT

SCALE 1/4" = 1'-0"

7

E F G H

U. S. ARMY

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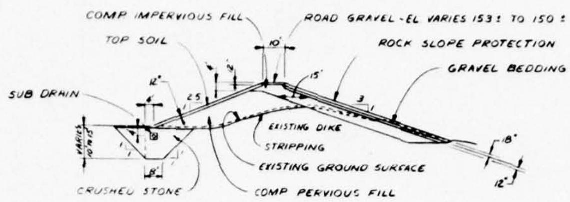
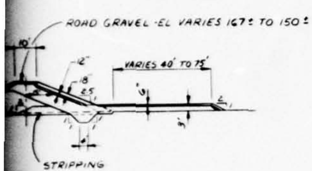
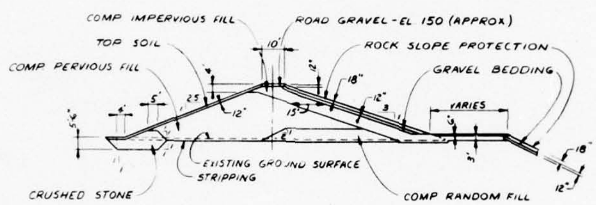



SECTION F

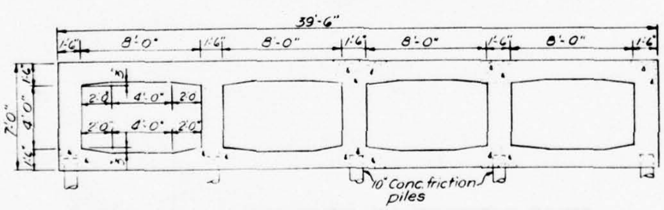



N D, E & H

SAME A
6"




SECTION G

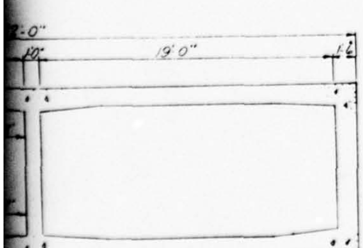



GATED OUTFLOW CONDUITS AT WESTFIELD RIVER

SCALE 1/4"=1'-0"

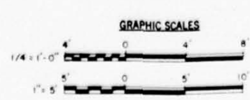

SILL

= 5'-0"




ROOK CONDUIT

1'-0"




WATER RESOURCES FEASIBILITY REPORT

WESTFIELD LOCAL PROTECTION

PLAN AND TYPICAL SECTIONS

WESTFIELD & LITTLE RIVERS MASSACHUSETTS

1 2 3 4 5 6 7 8

PLATE F-2

# SECTION G

## ECONOMICS OF THE SELECTED PLAN

SECTION G

# ECONOMICS OF THE SELECTED PLAN

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# SECTION G

# ECONOMIC OF THE SELECTED PLAN

The function of this section is to present the economics of the selected plan. The methodology of benefit-cost analysis is explained and the annual costs and benefits are derived and presented. Future benefits are similarly displayed. The benefit-cost ratio is formulated, and benefit maximization is determined. The material presented in this section concerns only those facets of the proposed improvement which can be readily quantified in dollar values.

## METHODOLOGY

The tangible economic justification of the proposed improvements, which provide essentially complete flood protection against a Standard Project Flood in the highly urbanized flood plain of Westfield, may be determined by comparing the average annual charges (i.e., interest, amortization, and operation and maintenance) to an estimate of the average annual benefits which are anticipated to be realized over the 100-year period of analysis selected. The average annual benefits must equal or exceed the annual costs if the project is to be recommended for Federal participation.

The values given to benefits and costs at their time of accrual are made comparable by conversion to an equivalent time basis using an appropriate interest rate. An interest rate of 6-7/8 percent applicable to public projects is used in this report. The net effect of converting benefits and costs in this manner is the development of comparable average annual values.

Because of the high degree of protection afforded and the high quality of maintenance that would be required for flood control works in an established urban area, the physical life of the works would exceed 100 years. Based on these factors, a 100-year period of analysis was selected.

The development of costs and benefits in this report follows standard Corps of Engineers practice. The value of all goods and

services used in the project is estimated on the cost side. On the benefit side, damages prevented, both present and future, and location benefits are estimated. The assessment of damages prevented is based on flood damage surveys which provide dollar estimates of both physical and non-physical losses related to various stages or elevations of flooding. These losses are then related to stage-frequency data which result in expected losses on an annual basis. Annual benefits then are computed by subtracting total annual losses which would occur with the project from the total losses that would occur without the project. Graphic development of stage-damage and damage-frequency relationships are shown on the plates at the end of this section.

The final consideration is maximizing net quantifiable benefits. This is an economic concept directed toward sizing a project or investment to the point where the greatest excess of benefits over costs occurs. In effect, this is the point where the last increment in project size has an incremental cost unit equal to an incremental benefit unit. However, maximization does not reflect qualitative values. Plate G-2 describes the results of maximization studies with an Excess Benefits Curve.

## *COSTS*

### FIRST COSTS

The estimates of first costs provide for construction of the Selected Plan as described in Section F and shown on Plate F-1. The estimates provide for the construction of the earth dikes, concrete walls, pumping stations and other appurtenant items. Quantities of the principal construction items were estimated on the basis of a preliminary design which would provide safe structures for given conditions. The estimates for first costs were based on March 1978 prices. A contingency allowance of 20% is included. Engineering and design and supervision and administration are estimated in lump sum items based on the cost of similar projects throughout the Westfield area, and amount to 9% and 8%, respectively.

Table G-1 summarizes the estimated first cost of the selected plan of improvement. A detailed estimate of non-Federal costs is summarized in Table G-1 and shown in Table G-2.

TABLE G-1

SUMMARY OF ESTIMATED FIRST COSTS

FEDERAL COST

CONSTRUCTION COST

| | |
|---|---|
| Earth Dikes | $13,000,000 |
| Concrete Walls | 2,750,000 |
| Vehicular Gates | 460,000 |
| Railroad Gate | 260,000 |
| Pumping Stations | 2,700,000 |
| Gated Conduits | 970,000 |
| Interior Drainage | 2,330,000 |
| River Overflow Channels | 2,430,000 |
| Utility Relocations | 1,900,000 |
| Detours during Construction | 230,000 |
| Ancillary Works | 450,000 |
| Downstream Mitigation | 1,000,000 |
| Archaeological Mitigation | 800,000 |
| TOTAL CONSTRUCTION COST | $29,280,000* |
| Engineering & Design | 2,640,000 |
| Supervision & Administration | 2,340,000 |
| TOTAL ESTIMATED FEDERAL FIRST COST | $34,260,000 |
| ROUNDED TO | $34,300,000 |

NON-FEDERAL COST

| | |
|---|---|
| Lands and Damages | $ 3,600,000* |
| Utility Relocations | 1,200,000 |
| TOTAL ESTIMATED NON-FEDERAL FIRST COST | $ 4,800,000 |
| TOTAL ESTIMATED PROJECT FIRST COST | $39,100,000 |

*Includes 20% for contingencies.

TABLE G-2

ESTIMATED NON-FEDERAL COSTS

I. Real Estate Costs:

| | |
|---|---|
| Lands & Improvements (Fee & Permanent Easements) | $2,400,000 |
| Temporary Construction Easements | 220,000 |
| Severance Damages | 140,000 |
| Relocation Assistance | 90,000 |
| Acquisition Costs | 150,000 |
| SUB-TOTAL | $3,000,000 |
| Contingencies 20% | 600,000 |
| TOTAL FIRST COST | $3,600,000 |

II. Utility Relocation

| | |
|---|---|
| Sewer: 18" Force Main along Westfield River | $300,000 |
| Utility lines, highway bridge | 750,000 |
| Repave roads, replace sidewalks, etc. | 150,000 |
| TOTAL FIRST COST | $1,200,000 |

III. Operation and Maintenance

| | |
|---|---|
| Annual Maintenance: Mow grass, test pumps, etc. | $8,000 |
| Annual Emergency Simulation | 4,000 |
| Repairs of plant and equipment | 2,000 |
| ANNUAL TOTAL | $14,000 |

IV. Major Replacements (Estimated)

| | |
|---|---|
| Pumps and Engines | $3,000 |
| Sluice Gates & stems, street gates & leaves | 2,000 |
| Miscellaneous | 1,000 |
| ANNUAL TOTAL | $6,000 |

ANNUAL COSTS

Estimates of annual costs are based on a 100-year period of analysis. Since the construction activities will extend over a three-year period, interest during construction will be included. The investment cost thus is the total of first cost plus the interest during construction. Interest and amortizitation charges are based on an interest rate of 6-7/8 percent. The estimated cost of annual operation and maintenance also is included. Table G-3 shows the Federal and non-Federal investments, while Table G-4 summarizes the annual costs.

# *FLOOD LOSSES AND BENEFITS*

Flood control benefits are defined as flood damages prevented and are based on estimates of potential damages in the flood plain. The information compiled relates flood stages in feet to the respective recurring dollar damages to properties; these stage-damage relations are exhibited in Plates G-3 to G-18. The determination of annual damages requires the correlation of hydrological stage-frequency data and stage-damage information to produce damage-frequency curves included on Plates G-3 to G-18. Annual benefits are the dollar difference between damages occuring under natural or existing conditions, and those that still occur with the improvement.

Future flood control benefits are estimated by taking into account future hydrologic changes and economic development. The effects of flood control on the additional damages which result from these factors constitute a benefit to the project.

RECURRING LOSSES

Experienced losses are those losses that actually occurred during a specific historical storm. Recurring losses are those that are expected to occur in the future at various flood stages under present day levels of development. The damages that would occur in a recurrence of the record flood stages associated with the August 1955 hurricane under present day conditions in Westfield would exceed $100 million dollars (March 1978 price level). Seventy-four percent of expected recurring losses in Westfield would accrue to commercial and residential properties. The rapid development of the latter property types between 1955 and 1974 has more than tripled the potential losses. Table G-5 details the recurring losses by property type and as a percent of the total.

## TABLE G-3

## SUMMARY OF INVESTMENTS

### FEDERAL INVESTMENT

| | |
|---|---|
| Federal First Cost | $34,300,000 |
| Interest During Construction: ($34,300,000)(0.06875)(1/2x3) | 3,500,000 |
| TOTAL FEDERAL INVESTMENT | $37,800,000 |

### NON-FEDERAL INVESTMENT

| | |
|---|---|
| Non-Federal First Cost | $ 4,800,000 |
| Interest During Construction: ($4,800,000)(0.06875)(1/2x3) | 495,000 |
| | $ 5,295,000 |
| Rounded to | 5,300,000 |
| TOTAL NON-FEDERAL INVESTMENT | $ 5,300,000 |
| TOTAL FEDERAL AND NON-FEDERAL INVESTMENT | $43,100,000 |

## TABLE G-4

## SUMMARY OF ESTIMATED ANNUAL COSTS

| | |
|---|---|
| Federal | |
| Interest & Amortization (0.06883 x $37,800,000) | $2,600,000 |
| Non-Federal | |
| Interest & Amortization (0.06883 x $5,300,000) | $ 360,000 |
| Operation & Maintenance | 14,000 |
| Major Replacement (Estimated) | 6,000 |
| | $ 380,000 |
| TOTAL ANNUAL COST | $2,980,000 |

## TABLE G-5

Recurring Losses (in thousands)
1974 Conditions
1978 Price Level
1955 Flood = Zero Stage

| | 0 Stage (1974) | 0 Stage (1978) | Percent of Total | +3 Stage (1974) | +3 Stage (1978) | Percent of Total |
|---|---|---|---|---|---|---|
| AGR | 1,397.1 | 1,816.2 | 1.77 | 1,593.0 | 2,070.9 | 1.08 |
| COM | 32,231.8 | 41,901.3 | 40.91 | 43,592.7 | 56,670.5 | 29.58 |
| HWY | 991.0 | 1,288.3 | 1.26 | 3,045.0 | 3,958.5 | 2.07 |
| IND | 13,489.0 | 17,535.7 | 17.12 | 33,814.9 | 43,959.4 | 22.95 |
| PUB | 3,612.9 | 4,696.8 | 4.58 | 10,804.9 | 14,046.4 | 7.33 |
| RR | 60.0 | 78.0 | .08 | 320.0 | 416.0 | .22 |
| RES | 26,357.0 | 34,264.1 | 33.45 | 52,412.9 | 68,136.8 | 35.57 |
| U | 652.0 | 847.6 | .83 | 1,774.0 | 2,306.2 | 1.20 |
| Total | 78,790.8 | 102,428.0 | 100.00 | 147,357.4 | 191,564.7 | 100.00 |

The study area consists of (approximately) 2200 residences, 400 commercial establishments, 40 public buildings, 40 industrial concerns, and 15 farms.

BENEFITS

Damages expected under both present and future conditions are measured as flood control benefits when prevented with project implementation. Damages reduced to existing properties, future losses prevented, and location advantages to properties are the types of gains that result. Flood damages are designated generally as physical damages caused by inundation and associated non-physical losses incurred. These are sorted into property classifications, including residential, commercial, industrial, public and agricultural.

Economic damage zones are referenced to hydrologic index stations and their associated reaches. The flood area has been divided into seven zones as indicated on Plate G-1.

ANNUAL LOSSES

Stage-damage information obtained via field survey is combined with stage-frequency data to produce damage-frequency correlations. The probability of reaching each stage in a given year is multiplied by the corresponding damage, and these expected values are totalled. Based upon March 1978 levels and 1974 conditions, the average annual inundation loss* to existing properties amounts to $[illegible],331,000.

BASIC ANNUAL BENEFITS

These benefits are the dollar difference between the annual losses without a project, and the annual residual losses to be expected with a project in place. At March 1978 price levels and 1974 conditions annual benefits amount to $3,449,900.

The project causes slightly higher flood stages downstream of its eastern limit, along the Westfield River, in Westfield, West Springfield and Agawam. Twenty-four properties are affected. These properties were surveyed by damage appraisers, stage-damage and hydrologic frequency data were estimated and annual increased damages (negative benefits) of $12,700 were derived. The negative benefits were subtracted from flood control benefits to arrive at net basic benefits of $3,449,900.

| | |
|---|---|
| | $3,462,600 |
| - | 12,700 |
| | $3,449,900 |

---

*with Knightville and Littleville reservoirs

TABLE G-6

Annual Losses and Annual Flood Control Benefits
Selected Plan, Westfield, Massachusetts
by Damage Zone
1974 price level

| Zone | Annual Loss (w/o project) | Annual Loss (w/project) | Benefits |
|---|---|---|---|
| 1 | 486,000 | 184,000 | 302,000 |
| 2 | 192,400 | 84,000 | 108,400 |
| 3 | 134,200 | 43,200 | 91,000 |
| 4 | 162,200 | 72,000 | 90,200 |
| 5 | 1,834,000 | 86,400 | 1,747,600 |
| 6# | 396,000 | 95,000 | 301,000 |
| 7 | 201,000 | 108,200 | 92,800 |
| TOTAL | 3,405,800 | 672,800 | 2,733,000 |

#Zone 6 in 1973 prices due to resurvey of potential damages

Price Update to 1978: (update factor 1974 - 78 = 1.3)

| Zone | Benefits |
|---|---|
| 1 | 392,600 |
| 2 | 140,900 |
| 3 | 118,300 |
| 4 | 117,300 |
| 5 | 2,271,900 |
| 6 | 300,800 |
| 7 | 120,800 |
| TOTAL | 3,462,600 |

## LOCATION BENEFITS

The ability of the project to make protected flood plain land available to new activities that would use the flood plain only with the project results in location benefits. The value of this benefit is determined by employing two different techniques in accordance with Engineering Regulation (ER) 1105-2-351: (1) the change in the market value of land in the flood plain and (2) net income differences. Since more data and expert opinion was available using method (1), market value, final location benefits reflect this method. Consultation with the Westfield Planning Department resulted in the identification of sixty acres of flood plain land which could be utilized for higher uses with the selected plan. The total acreage was located in the following damage zones.

Zone 5; one 15 acre parcel
Zone 6; one 17 acre parcel
Zone 7; one 8 acre parcel
one 13 acre parcel
Zone 8; one 7 acre parcel

The sixty acres are currently agricultural or wooded land whose most likely future use with the project would be either commercial or industrial. No comparable land is available outside the flood plain. The Westfield Assessor and Chamber of Commerce were consulted for square foot values for industrial and commercial space after project implementation and under current conditions. It was assumed that eighty percent of the sixty acres would be developed after project implementation and that this growth would take ten years. Based on zoning, local growth patterns and planner opinions, it was assumed that 75 percent (36 acres) would be developed for commercial use and the remaining 25 percent (12 acres) for industrial use. Market value would be $2.00 per square foot for industrial and $.35 per square foot for commercial after project implementation but only one-half of those amounts without the project.

Commercial:

| | |
|---:|---|
| 43,560 | ft./acre |
| x $2.00 | |
| $87,120 | per acre |
| x 36 | acres |
| $3,136,320 | |

Industrial:

| | |
|---:|---|
| 43,560 | ft./acre |
| x $.35 | |
| $15,246 | |
| x 12 | acres |
| $182,952 | |

| | |
|---:|---|
| $3,136,320 | (Commercial) |
| 182,952 | (Industrial) |
| 3,319,272 | (Total Value with Project) |
| 1,659,636 | (Value without Project - 50%) |
| $1,659,636 | (Additional Gain in Land Value with Project) |

The Federal rate of return (9% HUD mortgage rate was used) converts the increased market value to an average annual benefit.

$$\$1,659,636 \times .09 = \$149,367$$

Updating to 1978 prices = $149,367 x 1.3 = $194,177

The location benefit of $194,177 is assumed to be reached ten years after project implementation and therefore must be discounted over the project life of 100 years at the prevailing interest of 6-7/8%. After discounting, the location benefit becomes $146,500.

AFFLUENCE BENEFITS

Affluence benefits are based on the assumption that the contents of residential structures will increase in value as the incomes of the dwellers of these residential units increase. Second only to agriculture, residential land use in Westfield currently accounts for nearly twenty percent of all developed land (see Table B-3 in Section B of this appendix). The city has used the flood plain for settlement and agriculture since early times. The area is flat, easy to build upon and accessible to roads and river travel. The flood plain represents about one-half of the land in the present core city. Within the area to be provided with flood protection by the selected plan are located: approximately 2200 residential units, 400 commercial establishments, 40 public buildings, 40 industrial concerns and 15 farms.

Reference to table G-5 shows that recurring losses in the Westfield flood plain are concentrated among commercial (41%), residential (33%) and industrial (17%) properties. The relative concentration of residential units in each damage zone (see plate G-1) in the Westfield flood plain depicted is Table G-7.

TABLE G-7

Number of Residential Units per Damage Zone in the Westfield Floodplain

| Damage Zone | Number of Units | Percent of Total |
|---|---|---|
| 1 | 354 | 16.3 |
| 2 | 467 | 21.4 |
| 3 | 136 | 6.2 |
| 4 | 522 | 24.0 |
| 5 | 457 | 21.0 |
| 6 | 25 | 1.1 |
| 7 | 217 | 10.0 |

The city of Westfield currently operates under the regular phase of Flood Insurance Program (HUD) as the flood insurance map was completed and published in June 1978 and adopted by the city in October 1978. The Westfield Planning Report (1976) also recommends that vacant flood plain land be used only for agriculture, open space and recreational uses in the future. It further recommends and encourages that all undeveloped flood plain land be zoned agricultural and that current occupants of the flood plain undertake floodproofing.

From an audit of Westfield assessment records for the flood damage survey and a "community housing survey" taken by the Westfield Planning Department (1975) it was determined that the average value of a residence in Westfield is approximately $32,500. Interviews taken during the damage survey and final damage totals indicated that the value of household contents was approximately forty percent of the value of the structure.

Employing the affluence factor methodology, the value of contents was increased to 75 percent of the structural value and limited to the first fifty years of project life. Thus the additional increment due to future content value based on affluence would be 87.5% (75% : 40%) The number of years that it would take for contents value to grow to the maximum 75 percent was calculated using the OBERS regional growth factor for per capita income. Data from OBERS projections for the Springfield-Chicopee-Holyoke SMSA, to which Westfield belongs, and which were used to calculate the growth period are shown in Table G-8.

TABLE G-8

Projected Levels of Per Capita Income for the Springfield-Chicopee-Holyoke SMSA Source OBERS, Series E

| | Per Capita Income | Percent Increase | Annual Compound Growth Rate |
|---|---|---|---|
| 1970 | $3,425 | | |
| 1980 | 4,700 | .3723 | .033 |
| 1990 | 6,100 | .2979 | .026 |
| 2000 | 8,100 | .3272 | .029 |
| 2020 | 13,100 | .6173 | .024 |
| 1970-2020 | | 3.8248 | .0275 |

Employing compound interest tables at an annual growth rate of 2.75% and an affluence factor of 0.875 it will take 23 years for the contents value to grow to 75% of the structural value of a residence.

Stage-damage curves were then prepared for contents losses for each damage zone. These losses were then combined with hydrologic data for each damage zone to produce annual damages. Annual damages to residential contents both "with" and "without" the project and under existing conditions and after adjustment for affluence are displayed in Tables G-9 and G-10.

TABLE G-9

Annual Losses and Benefits to Residential Contents; Existing Conditions without Affluence Adjustment

| Damage Zone | Annual Losses without project | Annual Losses with project | Benefits to Project |
|---|---|---|---|
| 1 | 41,600 | 11,520 | 30,080 |
| 2 | 37,490 | 13,800 | 23,690 |
| 3 | 12,520 | 3,880 | 8,640 |
| 4 | 44,570 | 16,400 | 28,170 |
| 5 | 41,950 | 9,560 | 32,390 |
| 6 | 2,300 | 710 | 1,590 |
| 7 | 19,960 | 6,180 | 13,780 |
| TOTAL | 200,390 | 62,050 | 138,340 |

Since it takes 23 years for content value to reach 75 percent of structural value and it is estimated that it will take six years to project completion, then affluence growth reaches the maximum 75 percent level during the seventeenth year of project life. ($P_{17}$).

TABLE G-10

Annual Losses and Benefits to Residential Contents-with Affluence Adjustment at $P_{17}$ (no discounting)

| Damage Zone | Annual Losses without project | Annual Losses with project | Benefits to Project |
|---|---|---|---|
| 1 | 78,000 | 21,600 | 56,400 |
| 2 | 70,290 | 25,900 | 44,390 |
| 3 | 23,480 | 7,300 | 16,180 |
| 4 | 83,570 | 30,750 | 52,820 |
| 5 | 78,660 | 17,930 | 60,730 |
| 6 | 4,310 | 1,330 | 2,980 |
| 7 | 37,430 | 11,590 | 25,840 |
| TOTAL | 375,740 | 116,400 | 259,340 |

The increase in annual losses and benefits due to application of the affluence factor in each damage zone exhibited in Table G-11.

TABLE G-11

Increased Losses and Benefits due to Affluence

| Damage Zone | Increase in Annual Res. Contents Losses without project | Increase in Annual Res. Contents Losses with project | Increase in Benefits |
|---|---|---|---|
| 1 | 36,400 | 10,080 | 26,320 |
| 2 | 32,800 | 12,100 | 20,700 |
| 3 | 10,960 | 3,420 | 7,540 |
| 4 | 39,000 | 14,350 | 24,650 |
| 5 | 36,710 | 8,370 | 28,340 |
| 6 | 2,010 | 620 | 1,390 |
| 7 | 17,470 | 5,410 | 12,060 |
| TOTAL | 175,350 | 54,350 | 121,000 |

Residential contents losses and benefits were then summarized at the following points of reference: $P_N$ = existing condition, $P_O$ first year of project life, $P_{10}$ = tenth year of project life and $P_{17}$ = seventeenth year when residential losses reach 75% and growth due to affluence is terminated; the results are displayed in Table G-12. Benefits which accrue after $P_O$ were discounted at an interest rate of 6-7/8 percent and a 100 year project life.

TABLE G-12

Summary of Residential Contents Losses and Benefits by Reference Points

| | $P_N$ | $P_O$ | $P_{10}$ | $P_{17}$ |
|---|---|---|---|---|
| Losses: | | | | |
| without Selected Plan | 200,400 | 246,100 | 303,700 | 324,300 |
| with Selected Plan | 62,100 | 76,200 | 94,100 | 100,400 |
| Benefits | 138,300 | 169,900 | 209,600 | 223,900 |

Total discounted affluence benefits are:

| | | | |
|---|---|---|---|
| $P_N$ | $P_O$ | = | $31,600 |
| $P_O$ | $P_{10}$ | = | 39,700 |
| $P_{10}$ | $P_{17}$ | = | 14,300 |
| | | | $85,600 |

A price update factor of 1.3 (1974 to 1978) increases the total benefit for affluence to $111,300.

EMPLOYMENT BENEFITS

NED "employment benefits" were not estimated for the Westfield flood control project due to the fact that the unemployment rates for the town of Westfield and the Springfield-Chicopee-Holyoke SMSA have fallen below the six percent criterion for "substantial unemployment". During the period when benefits were updated (Jan-May 1978) the rates for the two areas varied within the low to mid five percent range.

TABLE G-13

Summary of Benefits

| | |
|---|---|
| Basic Flood Control | $3,449,900 |
| Location | 146,500 |
| Affluence | 111,300 |
| Total Annual Benefits | $3,707,700 |

JUSTIFICATION

Economic justification is ascertained by comparing the estimated annual benefits with the equivalent average annual costs, including interest and amortization. The project is justified when the ratio of benefits over costs is equal to or exceeds unity. Benefits and charges are compared over the 100 year life of the project. Dollar values of costs and benefits that would accrue to the plan at different times were made comparable by conversion to an equivalent time basis using the current Federal interest rate of 6-7/8%. The project is justified with a Benefit to Cost Ratio of 1.24 to 1.0.

TABLE G-14

SUMMARY OF ECONOMIC ANALYSIS
AVERAGE ANNUAL COSTS AND BENEFITS

| | |
|---|---|
| Annual Costs | $2,980,000 |
| Annual Benefits | $3,707,700 |
| Benefit/Cost Ratio | 1.24 to 1.00 |

# MAXIMIZATION

Maximization of net tangible benefits is an economic concept utilized to size a project or investment to the point where the greatest excess of benefits over costs occurs. This is the point where the last increment in project size has an incremental cost equal to incremental benefits, and any further increase in size will not be incrementally justified. During the plan formulation phase of the study it was determined that a local protection project was the preferred flood control solution that would meet the social, environmental and economic criteria. Of the several plans of local protection considered, the selected plan was the one which best met these criteria. The selection of the height of the protective works then became the remaining variable. The height of protection which results in the greatest excess of benefits over costs is the most efficient from an economic consideration.

Basic flood control benefits for the existing state of development in Westfield, net of negative effects downstream of the project, at specific levels of protection for the selected plan, the excess benefits, and related cost information are shown in Table G-15. The Excess Benefits Curve is shown on Plate G-2.

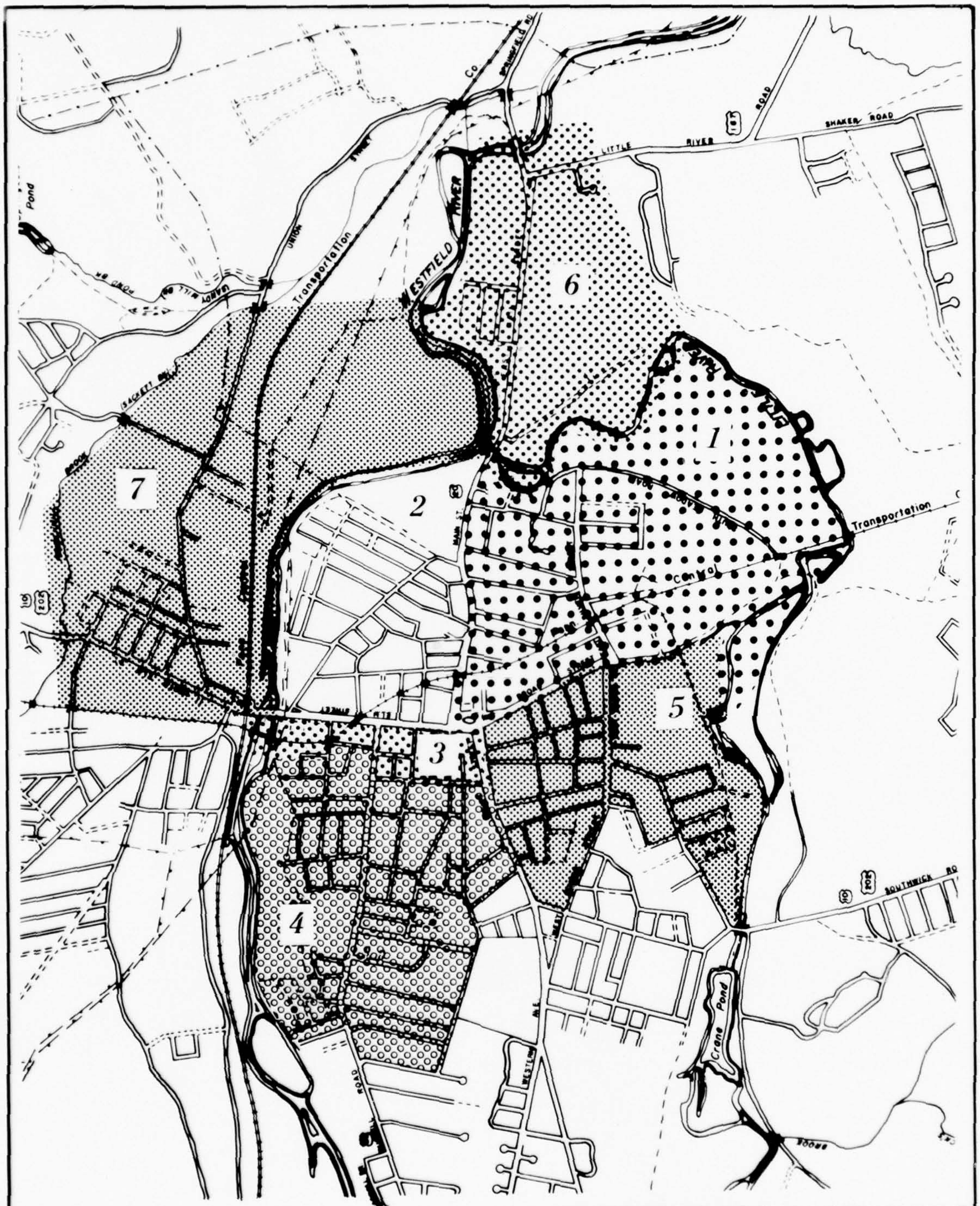
TABLE G-15

EXCESS BENEFITS

| | STAGE (in feet above Aug 1955 flood level) | | | | |
|---|---|---|---|---|---|
| | 0 | +3 | +5 | +7 | +10 |
| FEDERAL INVESTMENT | $32,757,000 | $35,033,000 | $37,723,000 | $42,013,000 | $48,903,000 |
| NON-FED. INVESTMENT | 5,043,000 | 5,167,000 | 5,277,000 | 5,387,000 | 5,497,000 |
| ANNUAL BENEFITS | 2,928,300 | 3,334,400 | 3,597,900 | 3,753,700 | 3,969,900 |
| TOTAL ANNUAL COST | 2,620,000 | 2,788,000 | 2,978,000 | 3,284,000 | 3,765,000 |
| EXCESS BENEFITS | $308,300 | $546,400 | $619,900 | $469,900 | $234,900 |

NOTE

For purposes of maximazation of excess benefits, only basic flood control benefits were considered. These basic benefits account for 93% of total benefits.




WESTFIELD L.P.P.

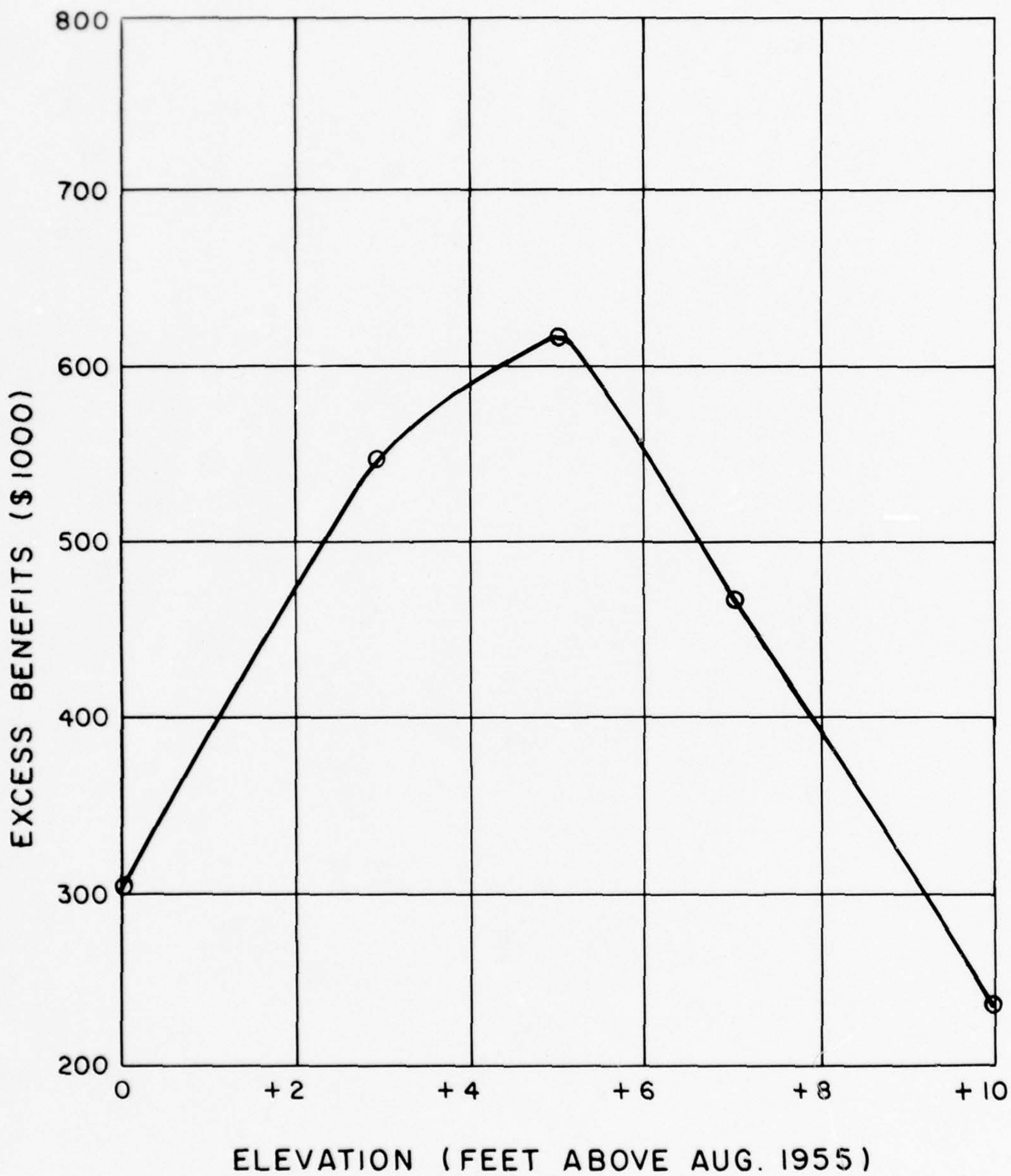
FLOOD DAMAGE ZONES

WESTFIELD RIVER

LITTLE RIVER

POWDER MILL RIVER

PLATE NO. G-1

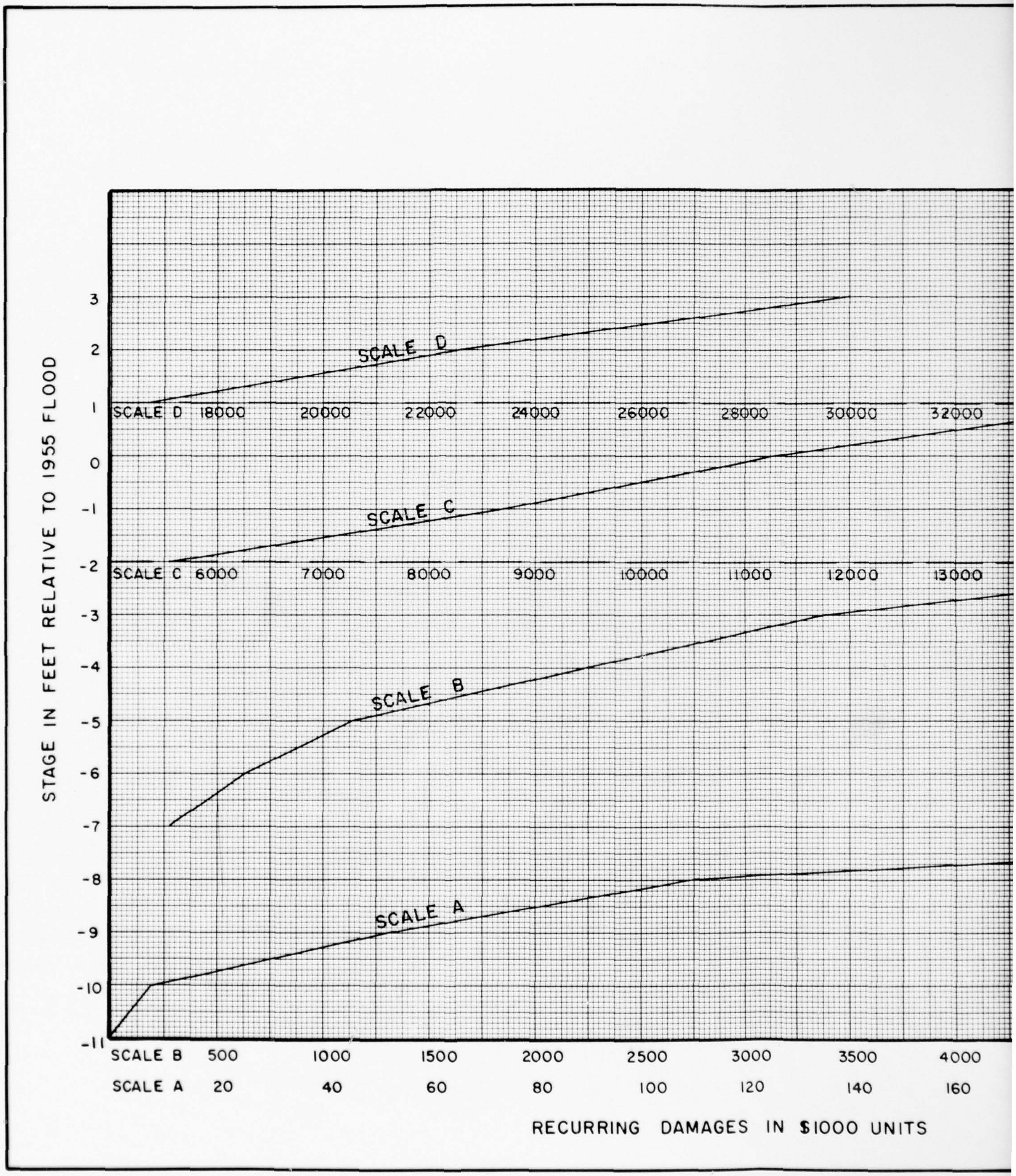



WESTFIELD LOCAL PROTECTION

EXCESS BENEFITS

CURVE

PLATE G-2


STAGE IN FEET RELATIVE TO 1955 FLOOD
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
SCALE D
SCALE C
SCALE B
SCALE A
SCALE D 18000 20000 22000 24000 26000 28000 30000 32000
SCALE C 6000 7000 8000 9000 10000 11000 12000 13000
SCALE B 500 1000 1500 2000 2500 3000 3500 4000
SCALE A 20 40 60 80 100 120 140 160
RECURRING DAMAGES IN $1000 UNITS

STAGE - DAMAGE CURVE
LITTLE RIVER
WESTFIELD, MASS.
ZONE I
1978 CONDITIONS
1974 PRICE LEVEL

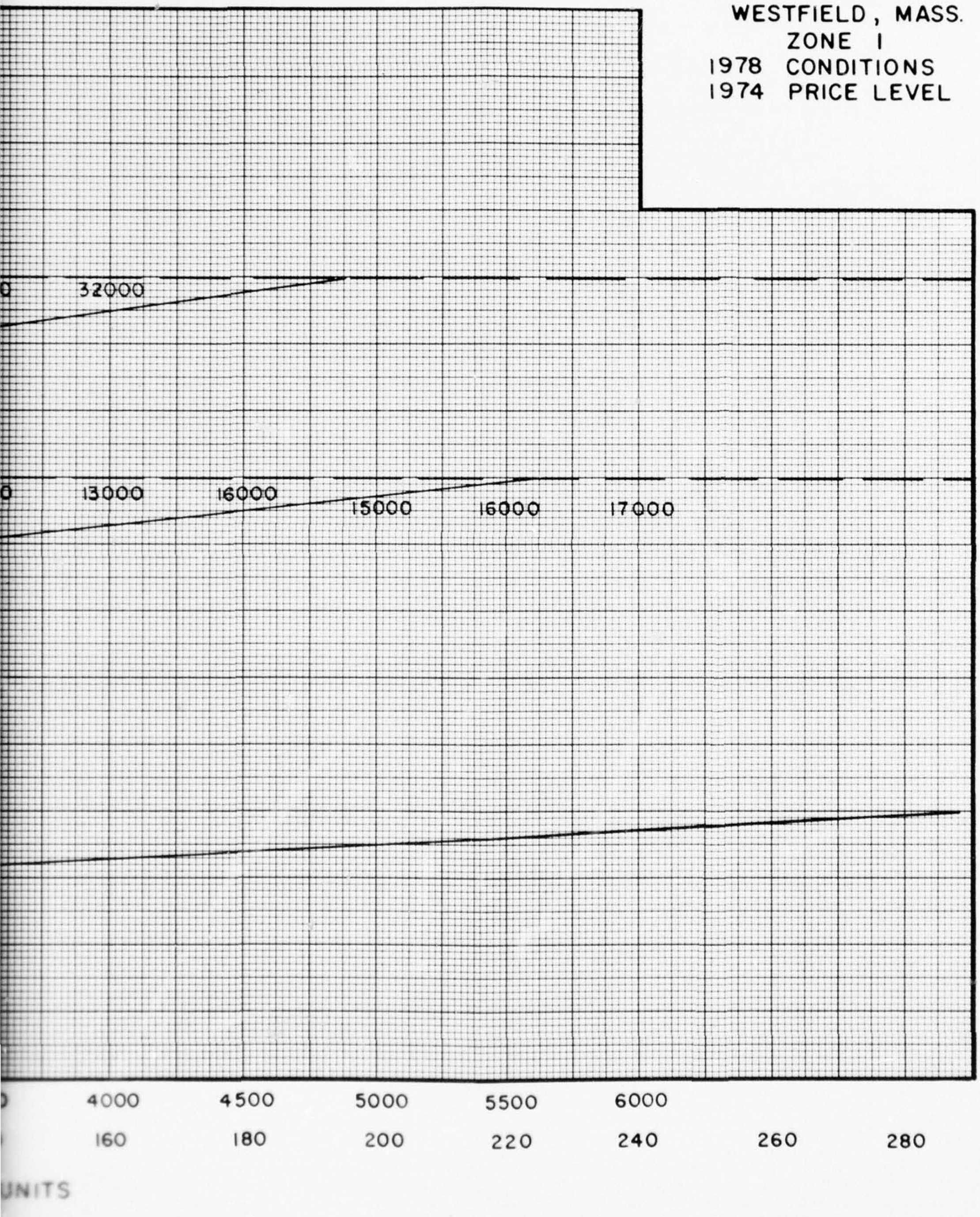
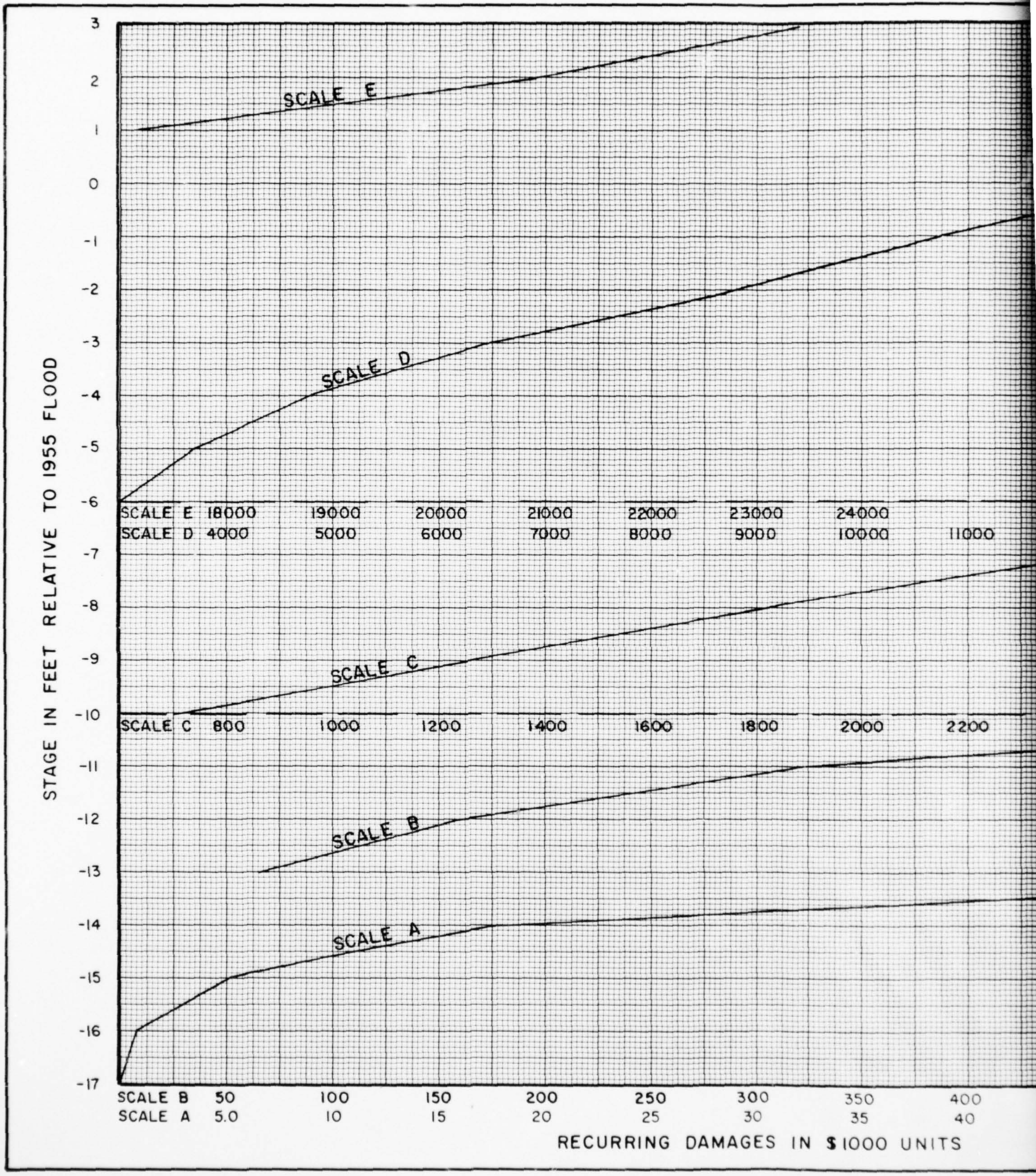



PLATE G-3



SCALE E
SCALE D
SCALE C
SCALE B
SCALE A
SCALE E 18000 19000 20000 21000 22000 23000 24000
SCALE D 4000 5000 6000 7000 8000 9000 10000 11000
SCALE C 800 1000 1200 1400 1600 1800 2000 2200
SCALE B 50 100 150 200 250 300 350 400
SCALE A 5.0 10 15 20 25 30 35 40
STAGE IN FEET RELATIVE TO 1955 FLOOD
RECURRING DAMAGES IN $1000 UNITS

2

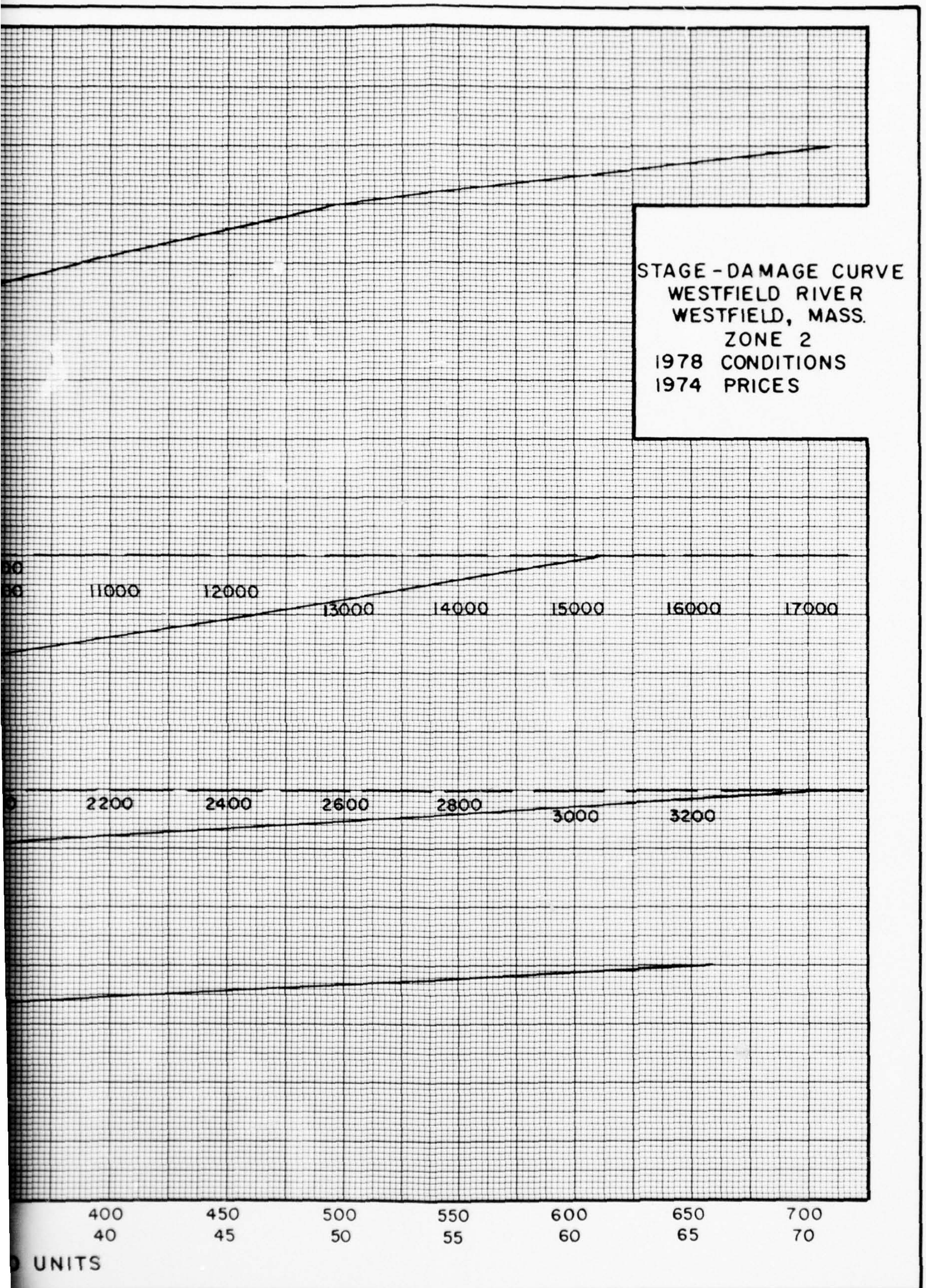
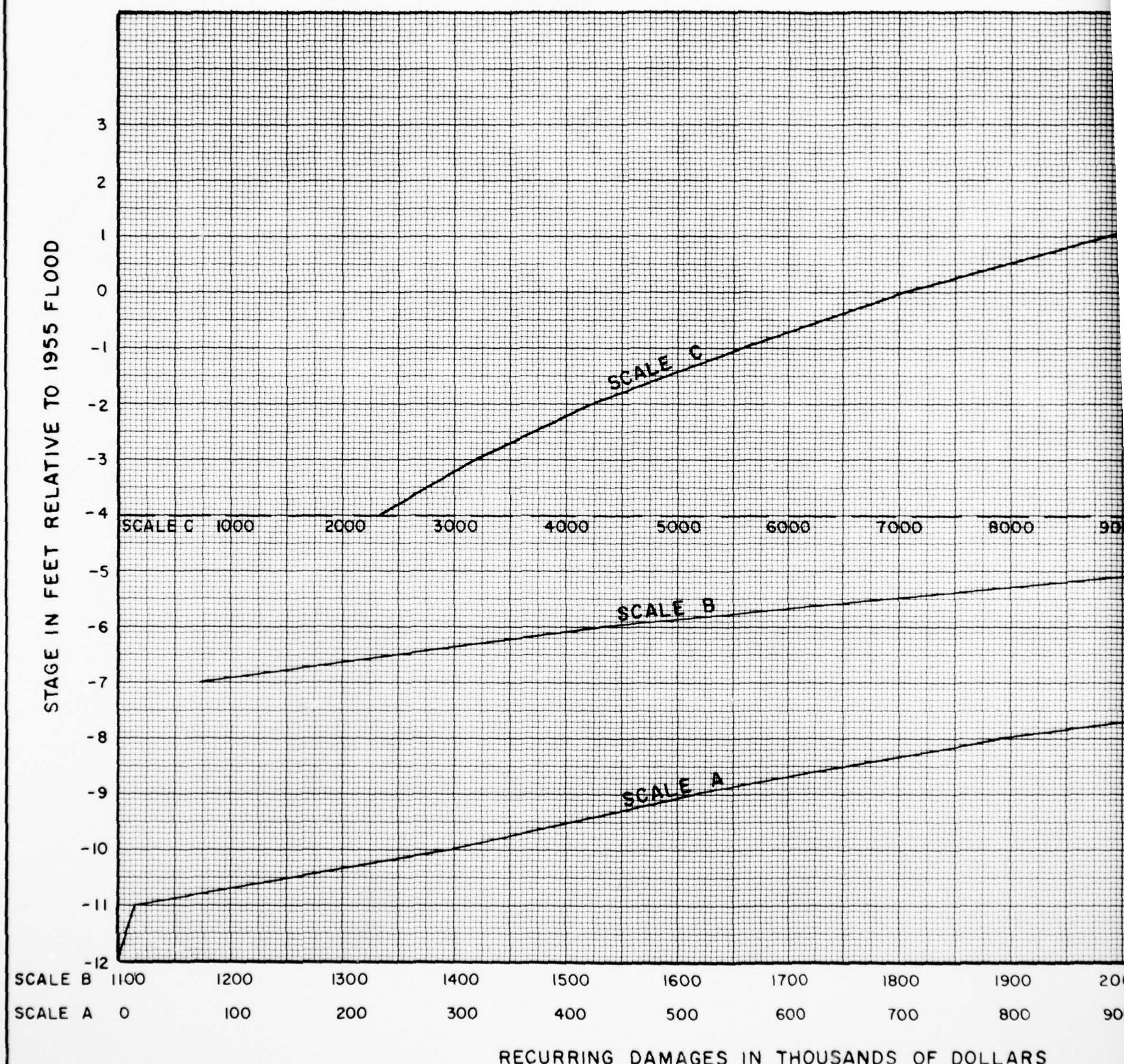

STAGE-DAMAGE CURVE
WESTFIELD RIVER
WESTFIELD, MASS.
ZONE 2
1978 CONDITIONS
1974 PRICES
11000
12000
13000
14000
15000
16000
17000
2200
2400
2600
2800
3000
3200
400 40
450 45
500 50
550 55
600 60
650 65
700 70
UNITS

PLATE G-4



STAGE IN FEET RELATIVE TO 1955 FLOOD
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
SCALE C
SCALE B
SCALE A
SCALE C 1000 2000 3000 4000 5000 6000 7000 8000
SCALE B 1100 1200 1300 1400 1500 1600 1700 1800 1900
SCALE A 0 100 200 300 400 500 600 700 800
RECURRING DAMAGES IN THOUSANDS OF DOLLARS

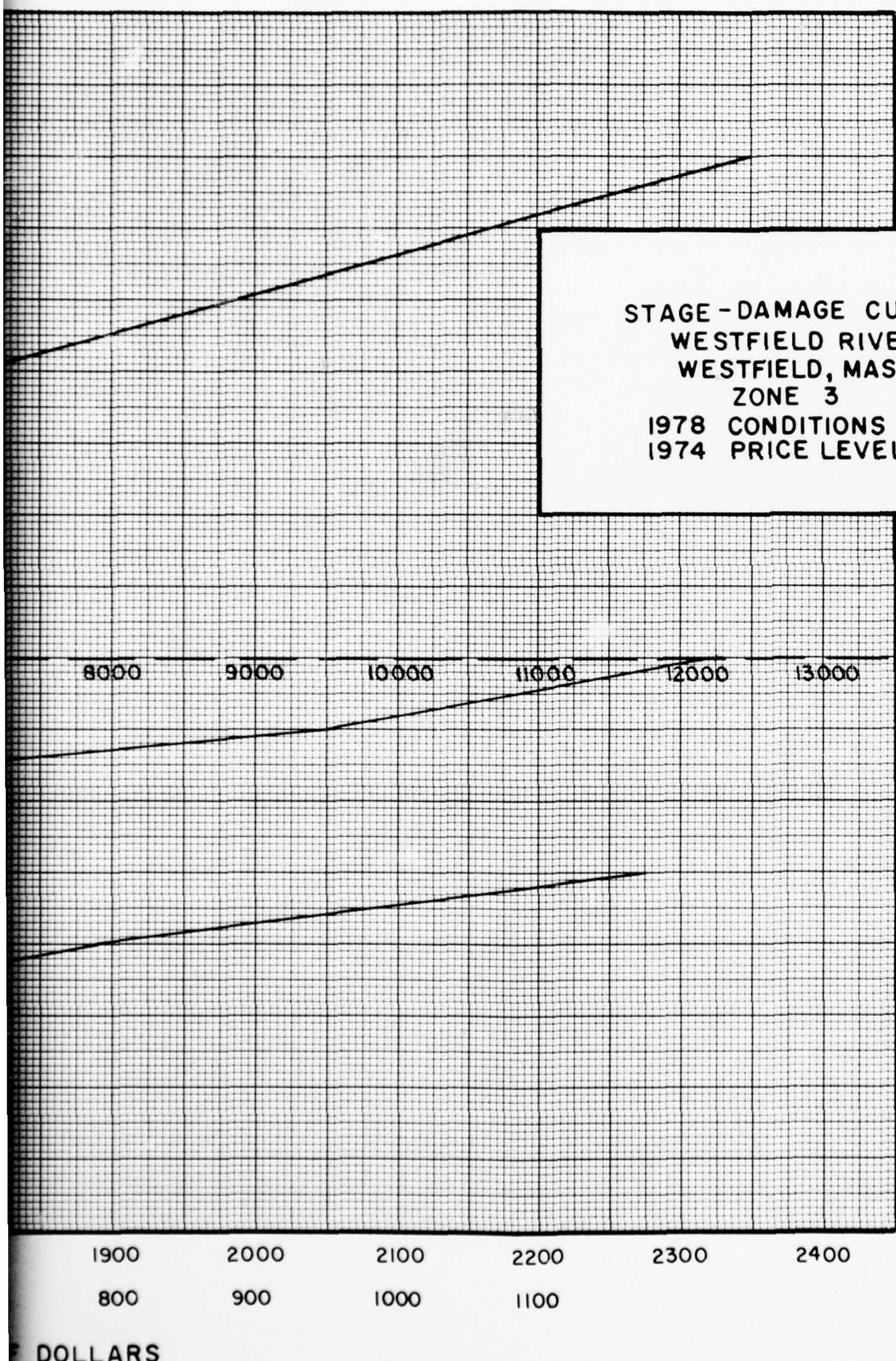
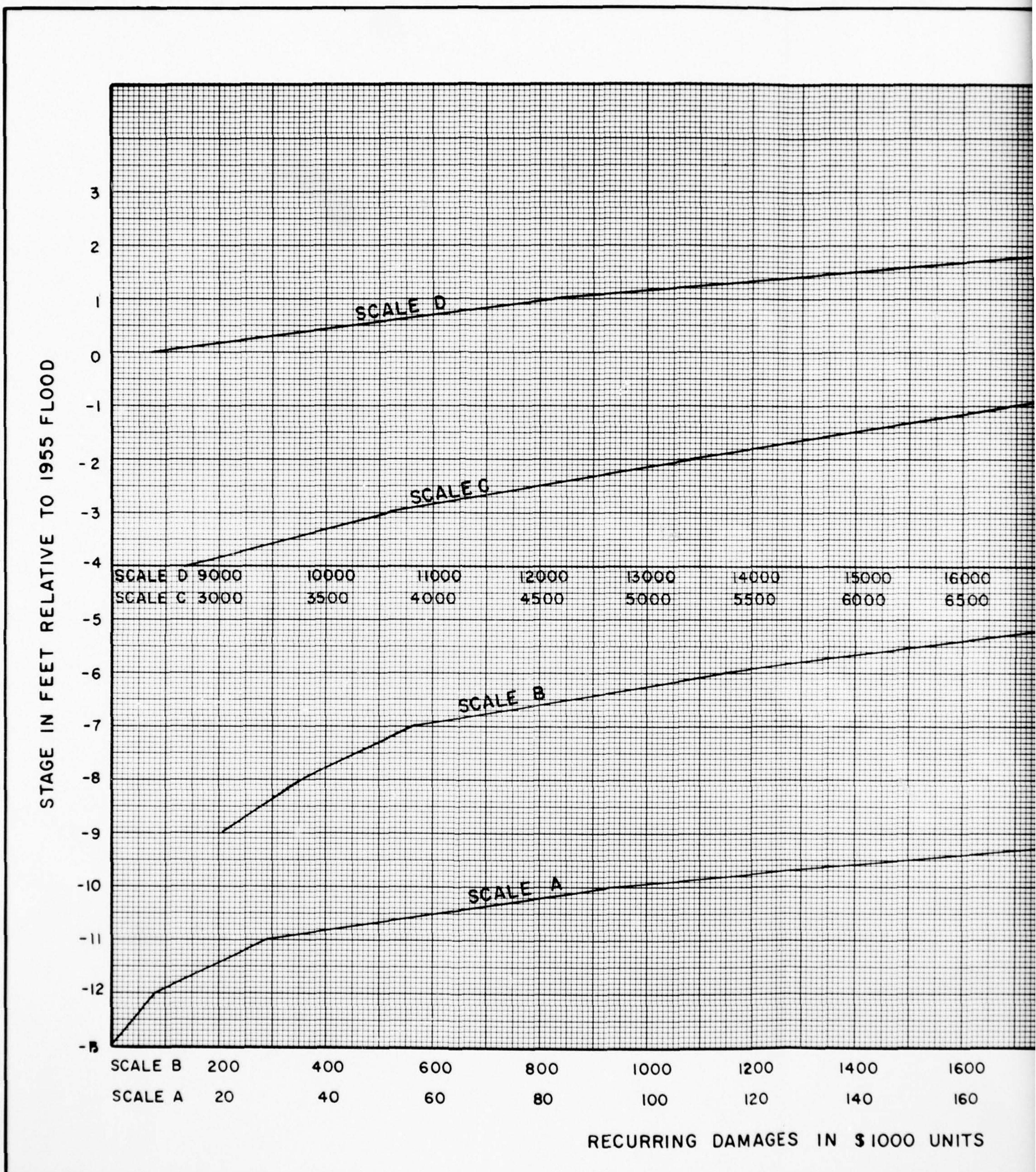
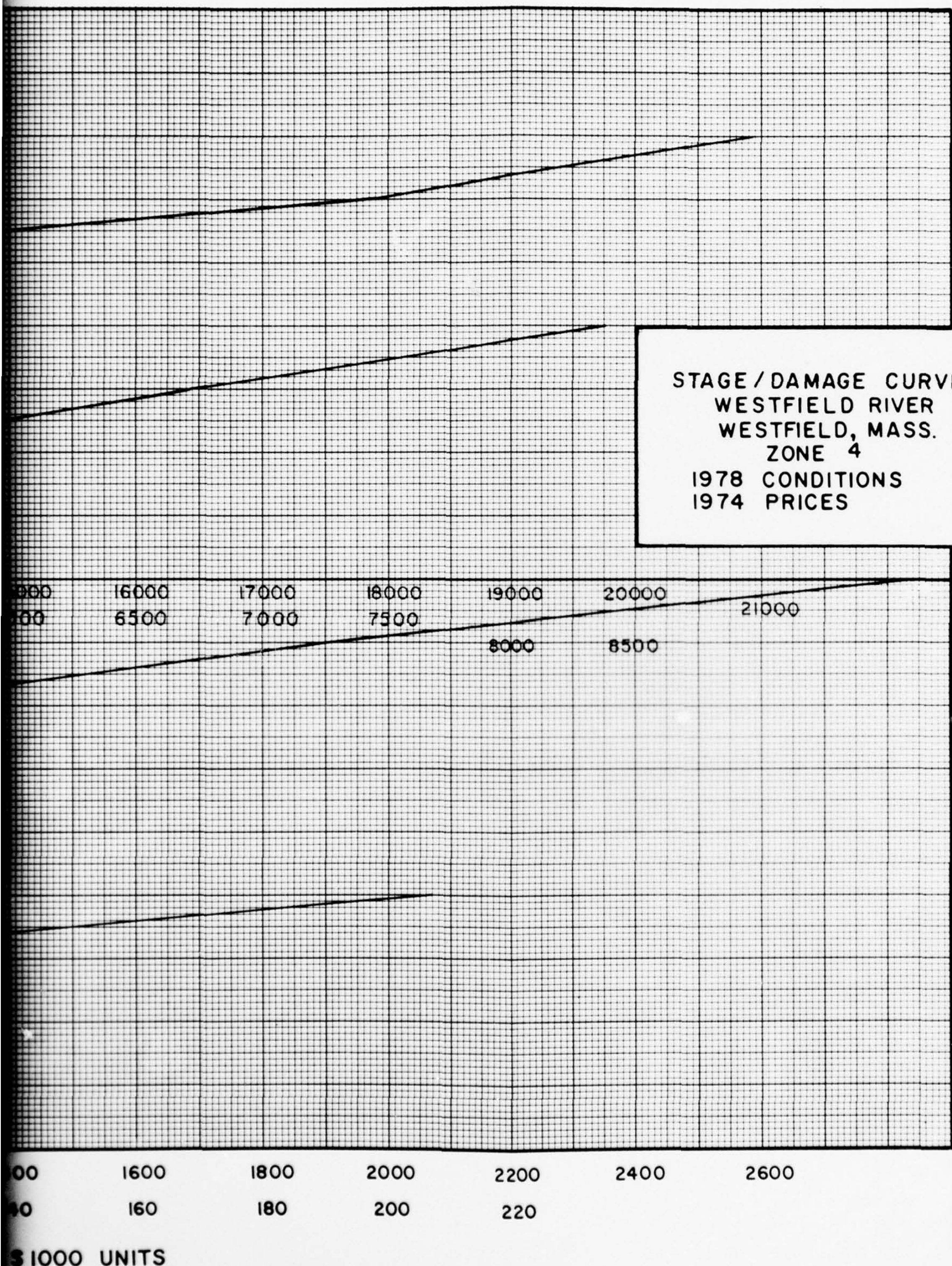
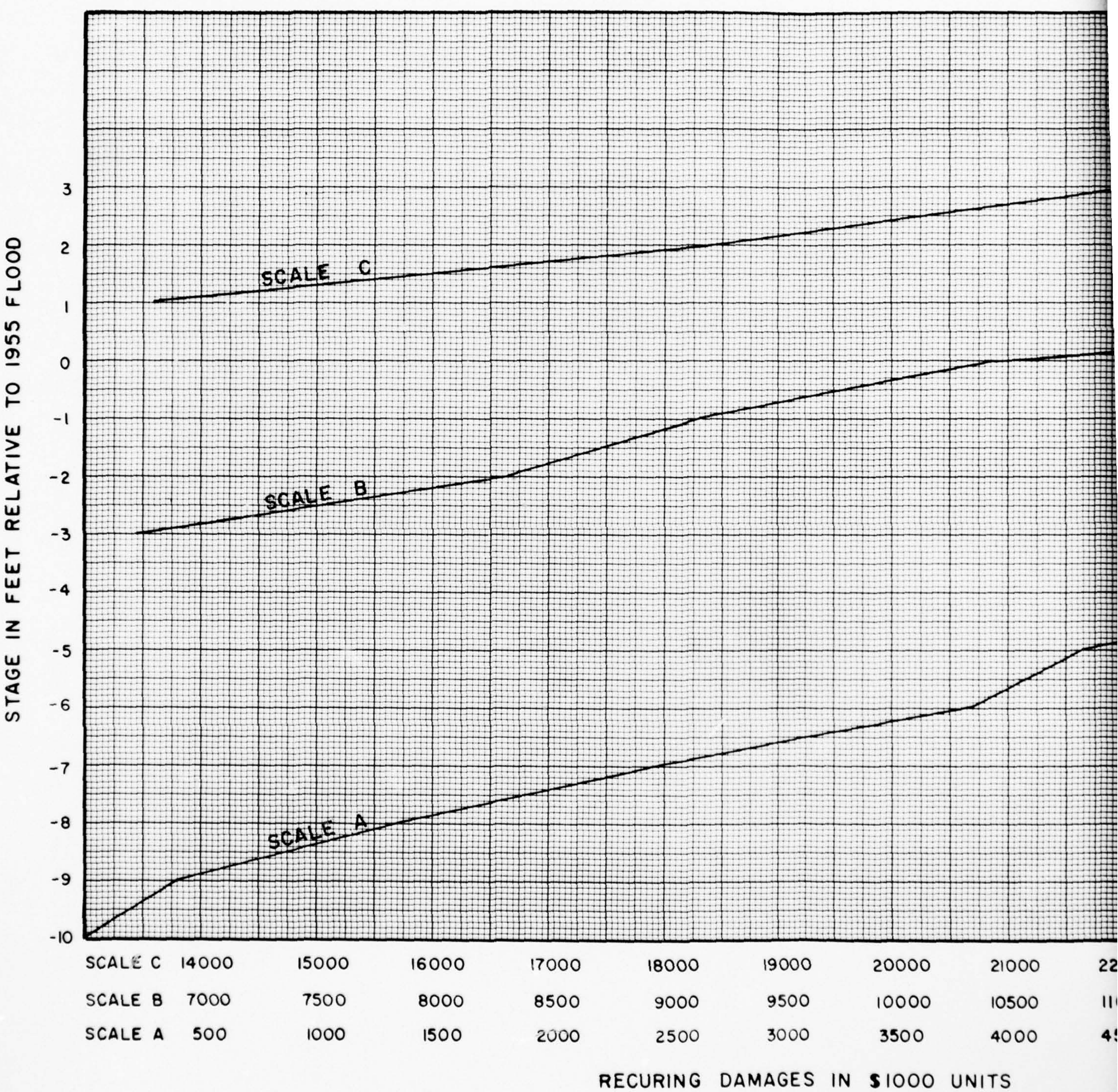

STAGE - DAMAGE CURVE
WESTFIELD RIVER
WESTFIELD, MASS.
ZONE 3
1978 CONDITIONS
1974 PRICE LEVEL
8000
9000
10000
11000
12000
13000
1900
2000
2100
2200
2300
2400
800
900
1000
1100
DOLLARS

PLATE G-5


STAGE IN FEET RELATIVE TO 1955 FLOOD
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
SCALE D
SCALE C
SCALE B
SCALE A
SCALE D 9000 10000 11000 12000 13000 14000 15000 16000
SCALE C 3000 3500 4000 4500 5000 5500 6000 6500
SCALE B 200 400 600 800 1000 1200 1400 1600
SCALE A 20 40 60 80 100 120 140 160
RECURRING DAMAGES IN $1000 UNITS

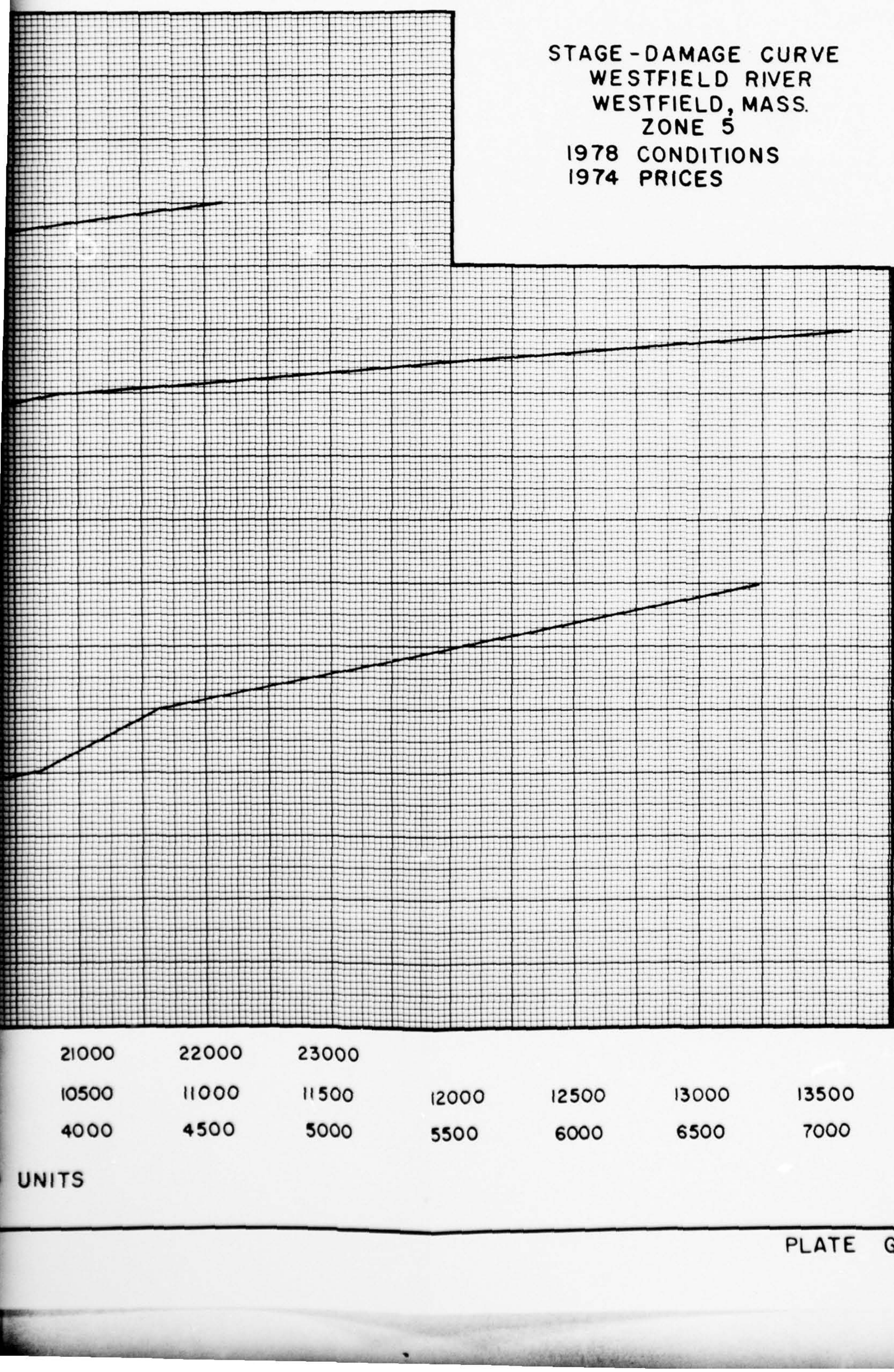


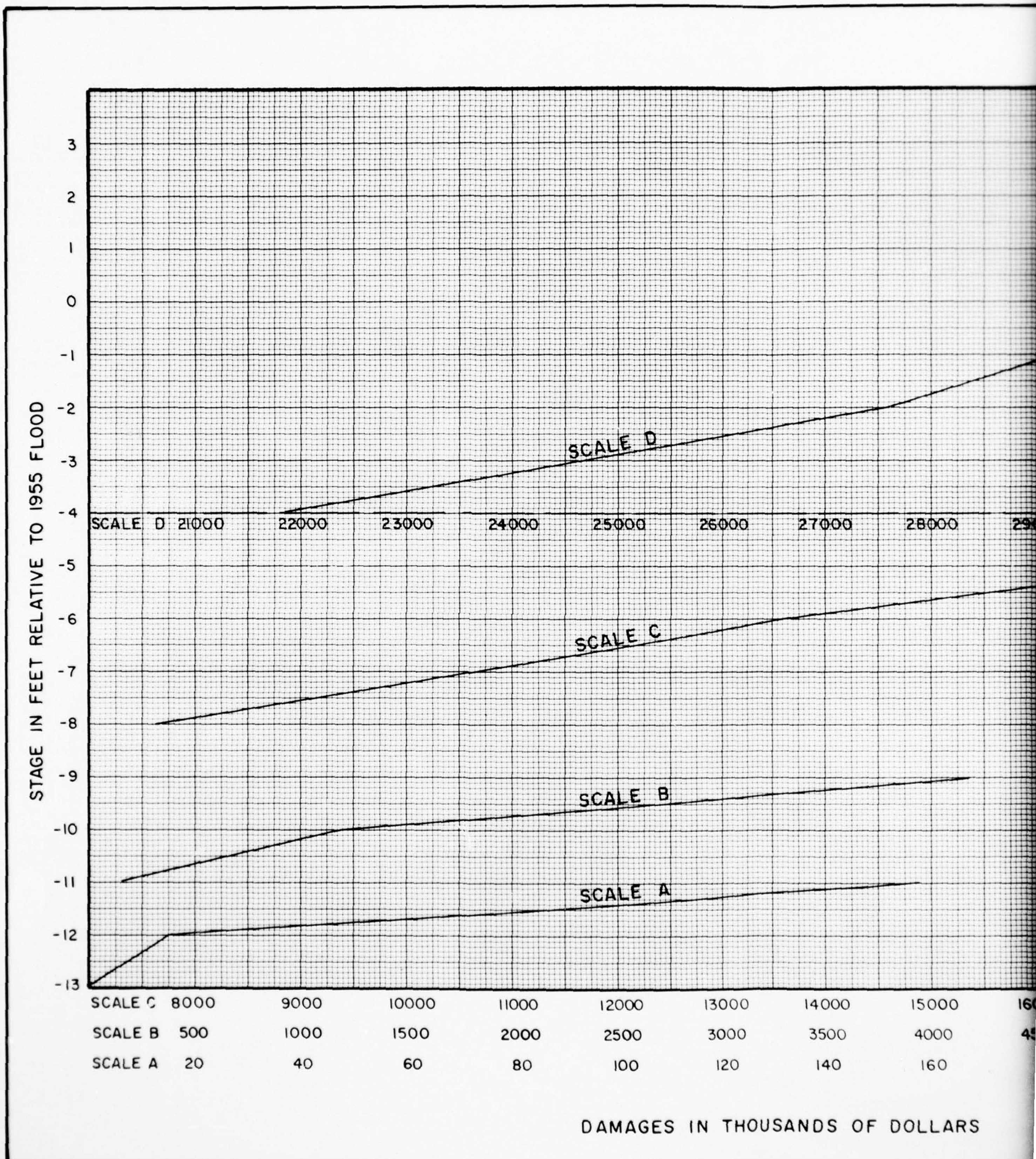

STAGE / DAMAGE CURVE
WESTFIELD RIVER
WESTFIELD, MASS.
ZONE 4
1978 CONDITIONS
1974 PRICES



STAGE IN FEET RELATIVE TO 1955 FLOOD
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
SCALE C
SCALE B
SCALE A
SCALE C 14000 15000 16000 17000 18000 19000 20000 21000 22
SCALE B 7000 7500 8000 8500 9000 9500 10000 10500 11
SCALE A 500 1000 1500 2000 2500 3000 3500 4000 4
RECURING DAMAGES IN $1000 UNITS

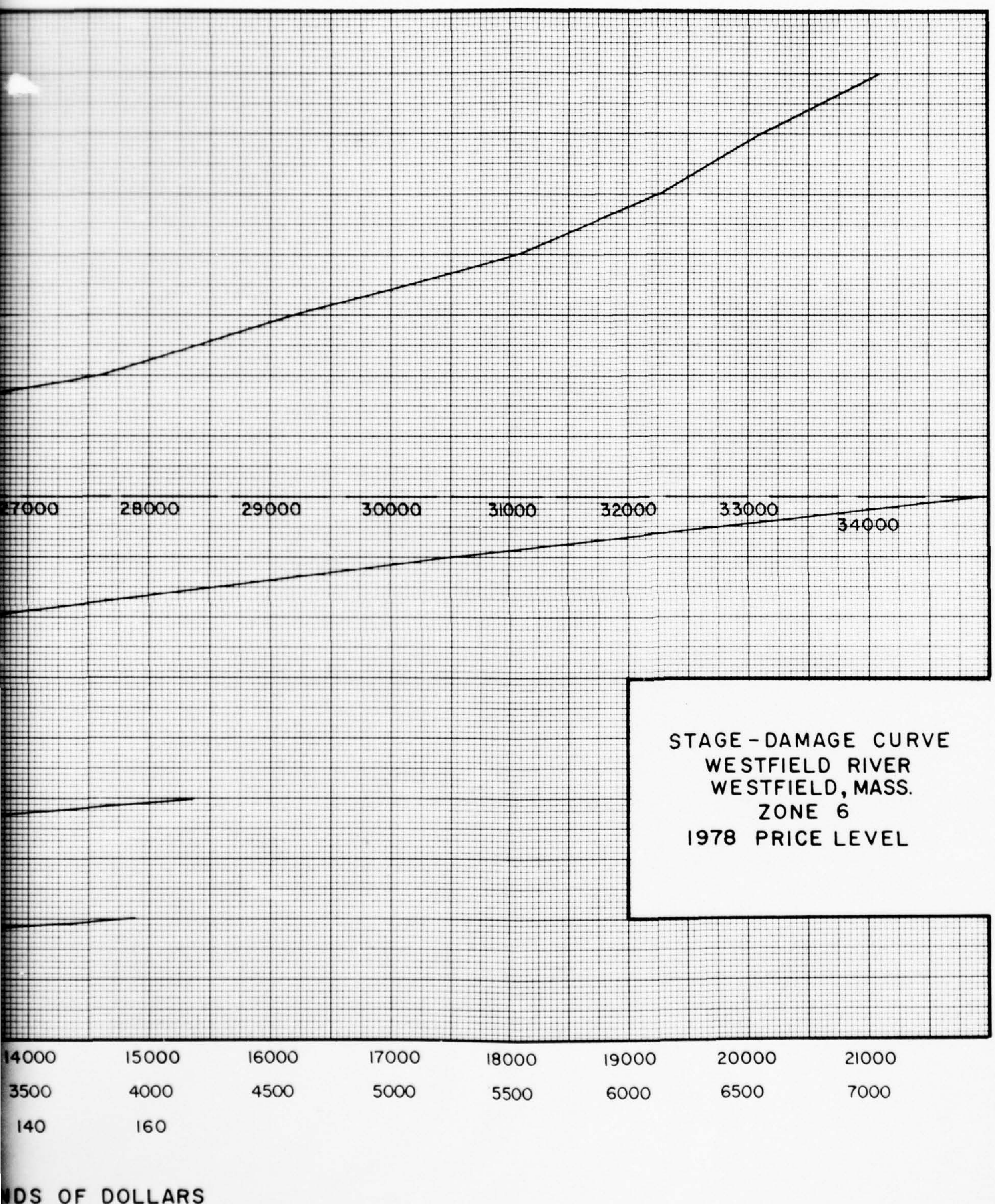
STAGE-DAMAGE CURVE
WESTFIELD RIVER
WESTFIELD, MASS.
ZONE 5
1978 CONDITIONS
1974 PRICES





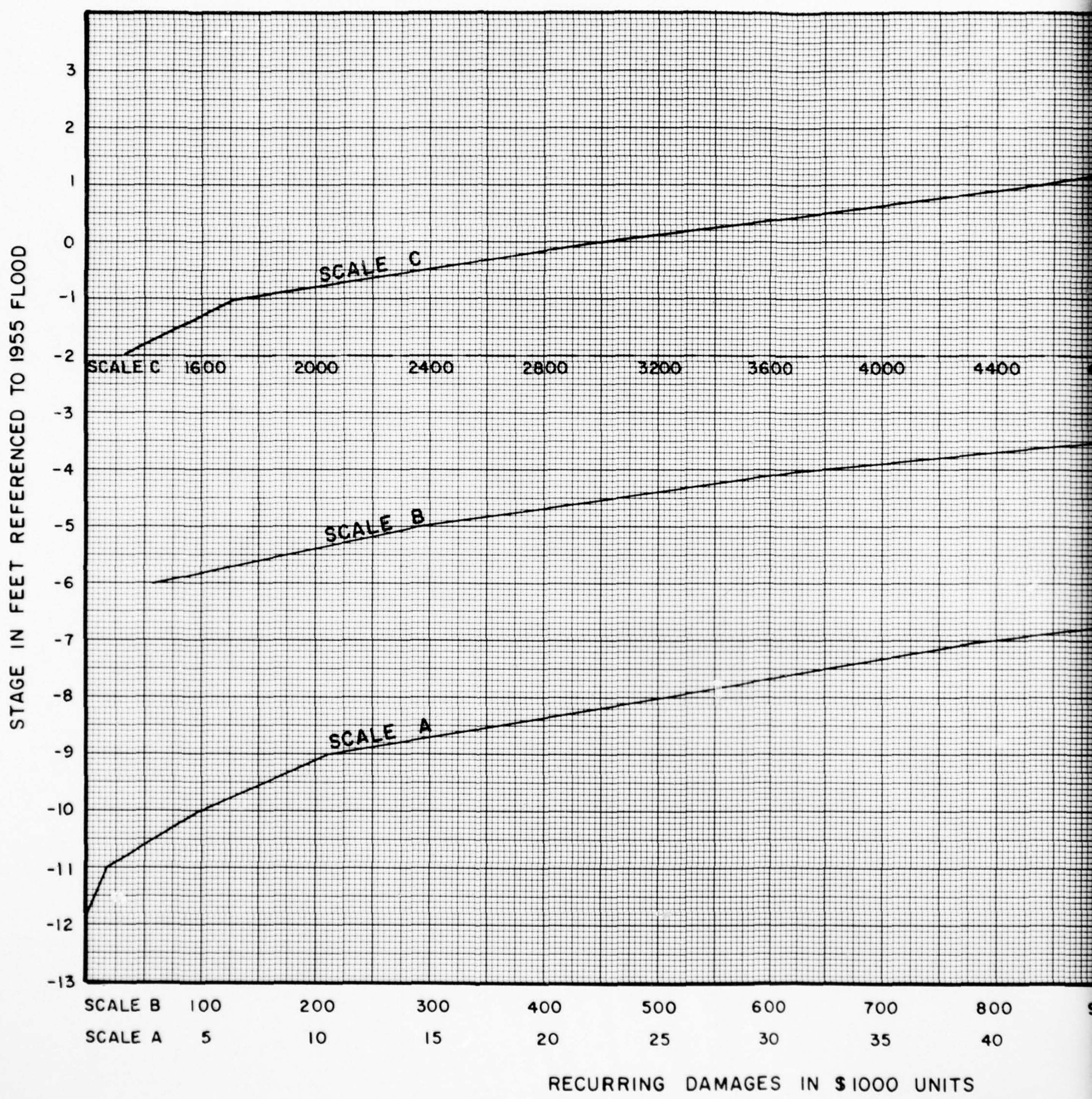
STAGE IN FEET RELATIVE TO 1955 FLOOD
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
SCALE D
SCALE C
SCALE B
SCALE A
SCALE D 21000 22000 23000 24000 25000 26000 27000 28000
SCALE C 8000 9000 10000 11000 12000 13000 14000 15000
SCALE B 500 1000 1500 2000 2500 3000 3500 4000
SCALE A 20 40 60 80 100 120 140 160
DAMAGES IN THOUSANDS OF DOLLARS

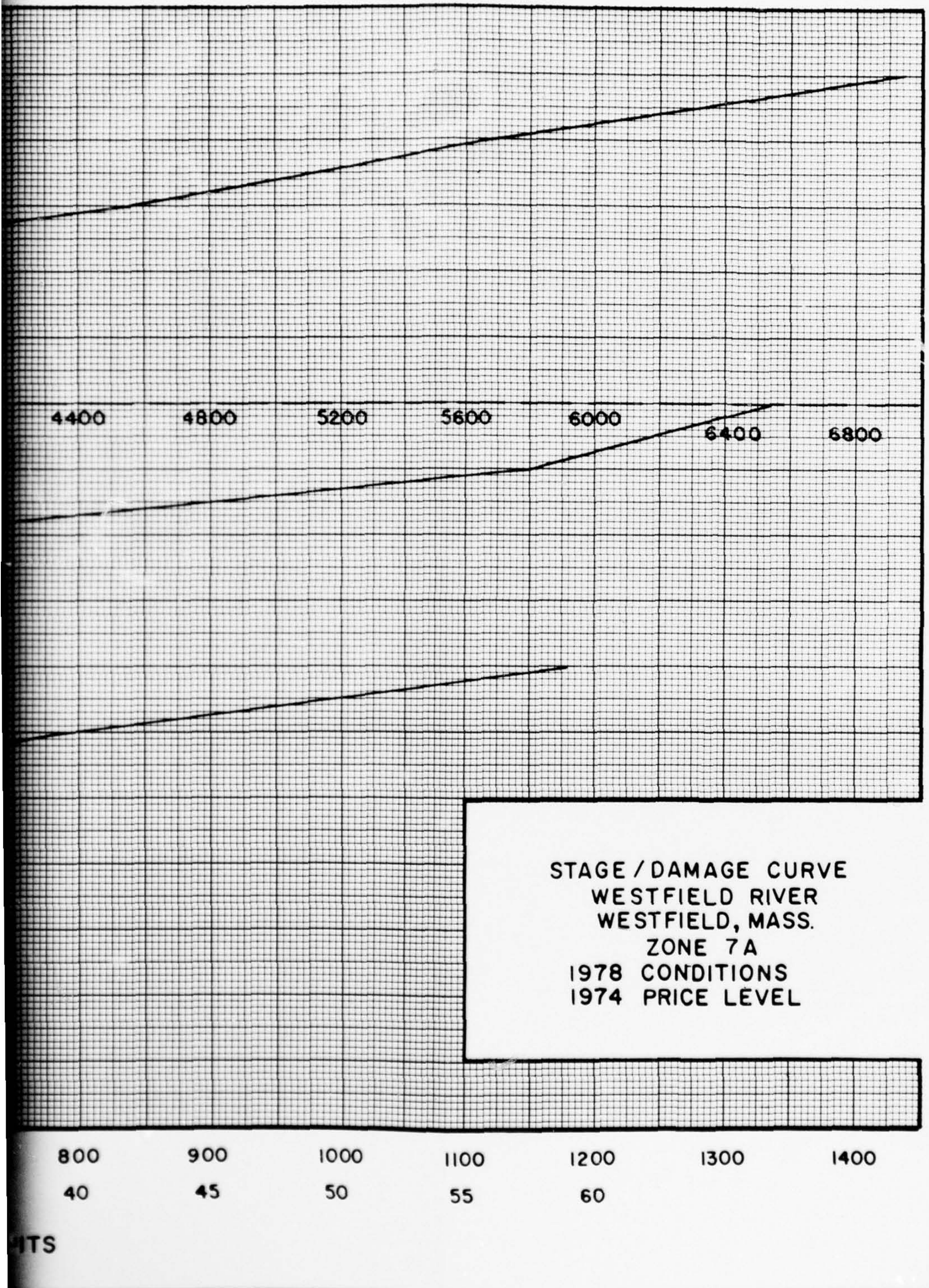
2



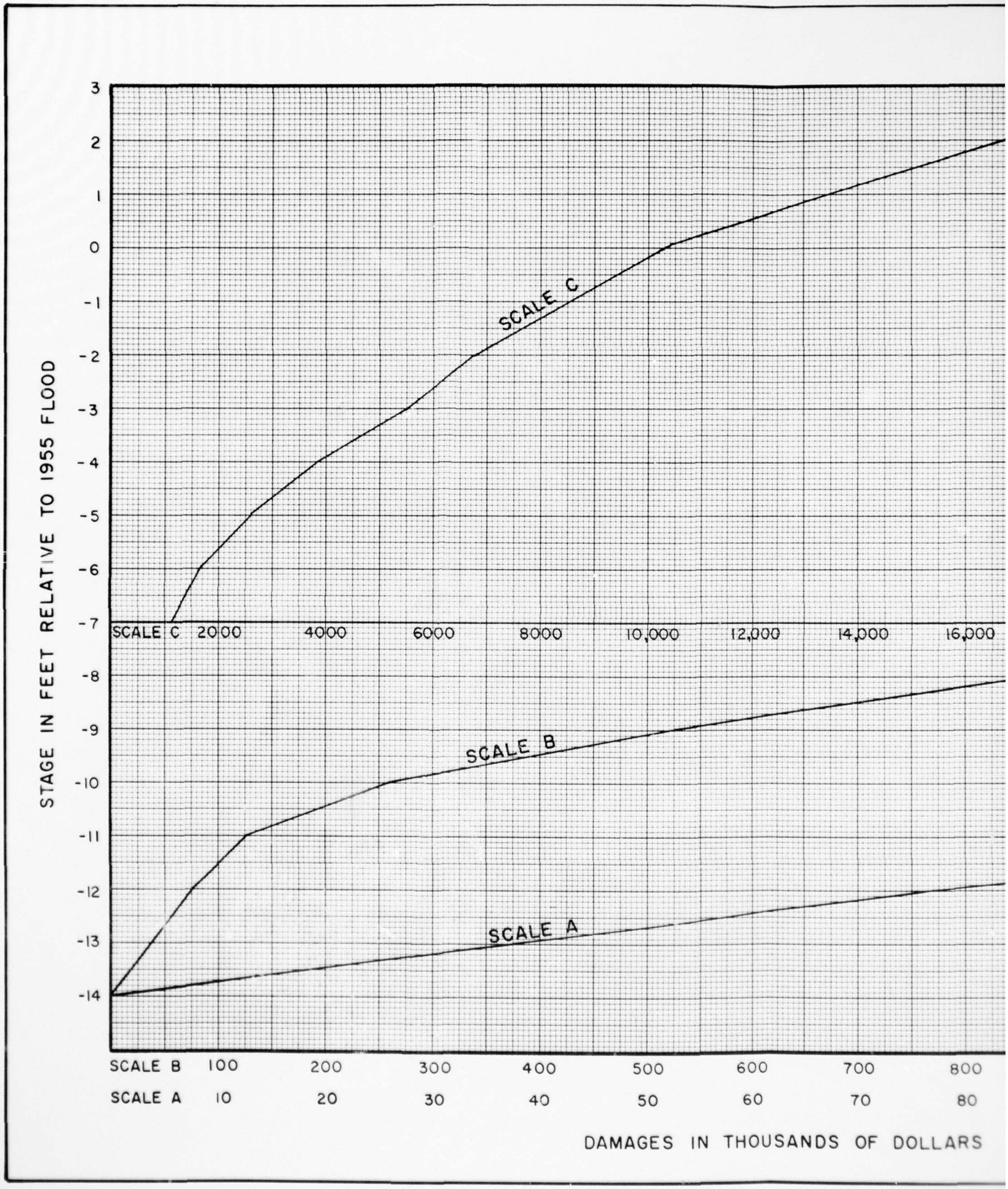

STAGE-DAMAGE CURVE
WESTFIELD RIVER
WESTFIELD, MASS.
ZONE 6
1978 PRICE LEVEL

PLATE G-8


STAGE IN FEET REFERENCED TO 1955 FLOOD
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
SCALE C
SCALE B
SCALE A
SCALE C 1600 2000 2400 2800 3200 3600 4000 4400
SCALE B 100 200 300 400 500 600 700 800
SCALE A 5 10 15 20 25 30 35 40
RECURRING DAMAGES IN $1000 UNITS




STAGE / DAMAGE CURVE
WESTFIELD RIVER
WESTFIELD, MASS.
ZONE 7A
1978 CONDITIONS
1974 PRICE LEVEL


STAGE IN FEET RELATIVE TO 1955 FLOOD
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
SCALE C
SCALE B
SCALE A
SCALE C 2000 4000 6000 8000 10,000 12,000 14,000 16,000
SCALE B 100 200 300 400 500 600 700 800
SCALE A 10 20 30 40 50 60 70 80
DAMAGES IN THOUSANDS OF DOLLARS

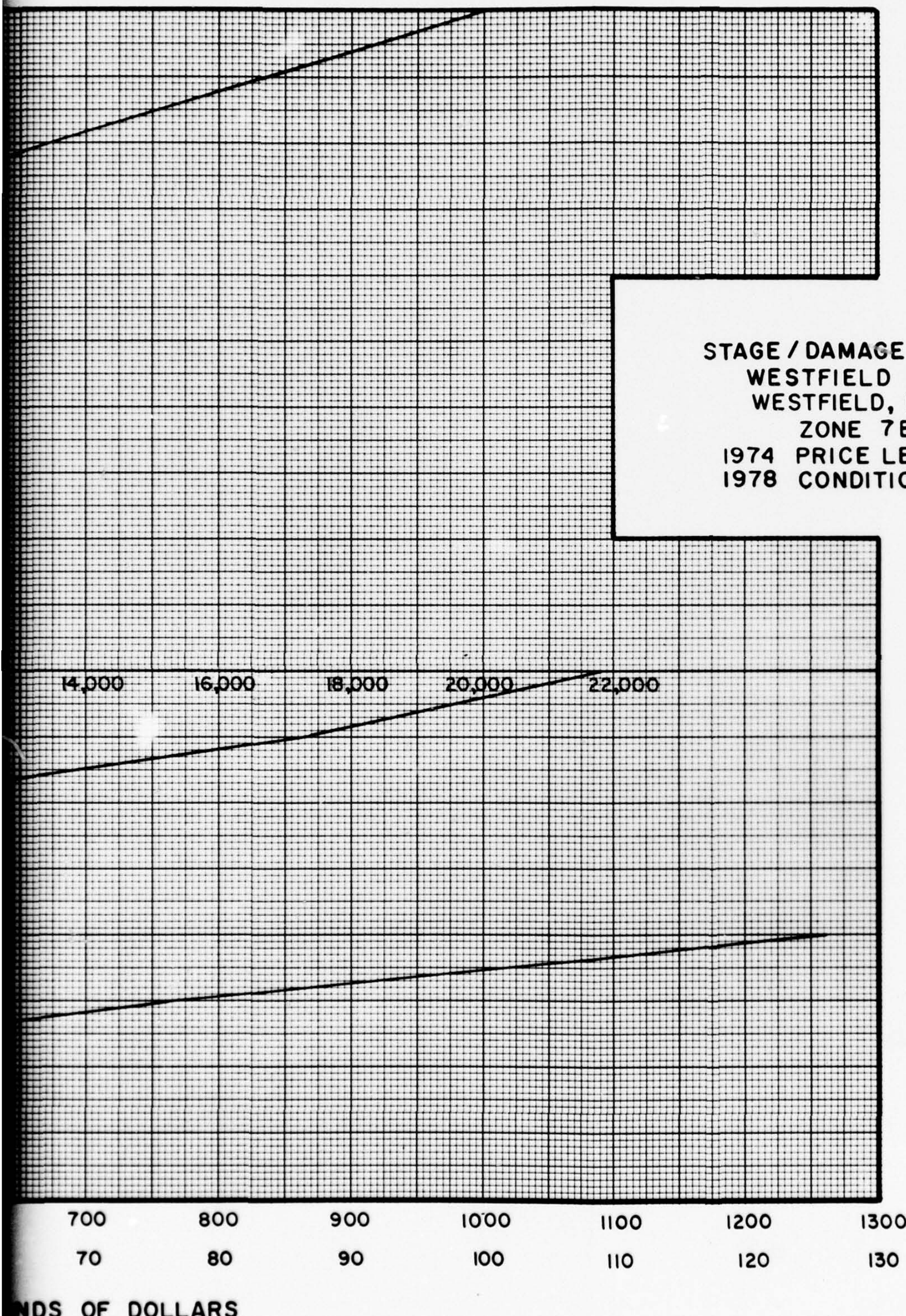
AD-A070 384 ARMY ENGINEER DIV NEW ENGLAND WALTHAM MA F/G 13/2
CONNECTICUT RIVER BASIN, WESTFIELD LOCAL PROTECTION, WESTFIELD --ETC(U)
APR 79

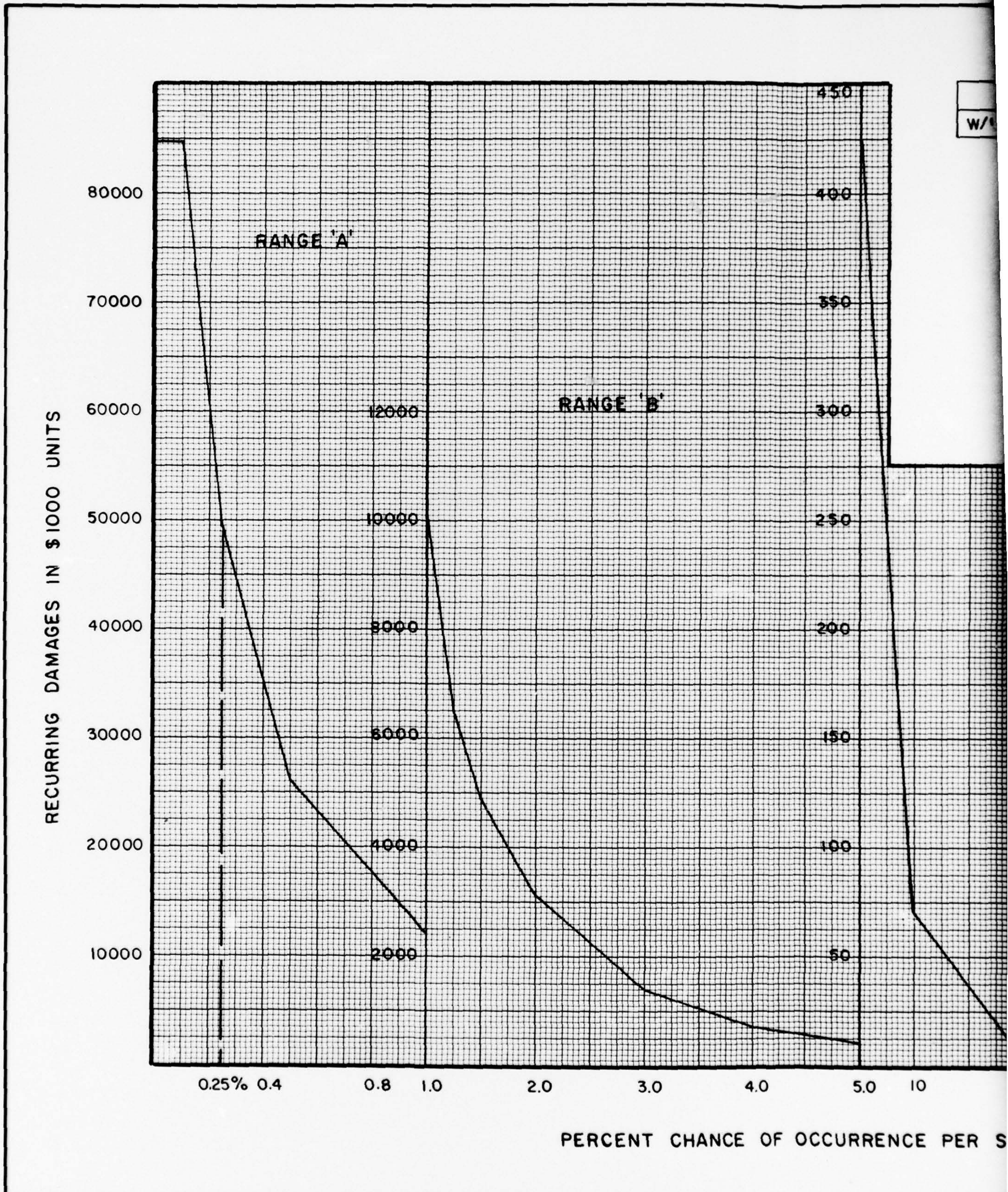
UNCLASSIFIED NL

4 OF 5
AD
A070384

2

STAGE / DAMAGE CURVE
WESTFIELD RIVER
WESTFIELD, MASS.
ZONE 7B
1974 PRICE LEVEL
1978 CONDITIONS

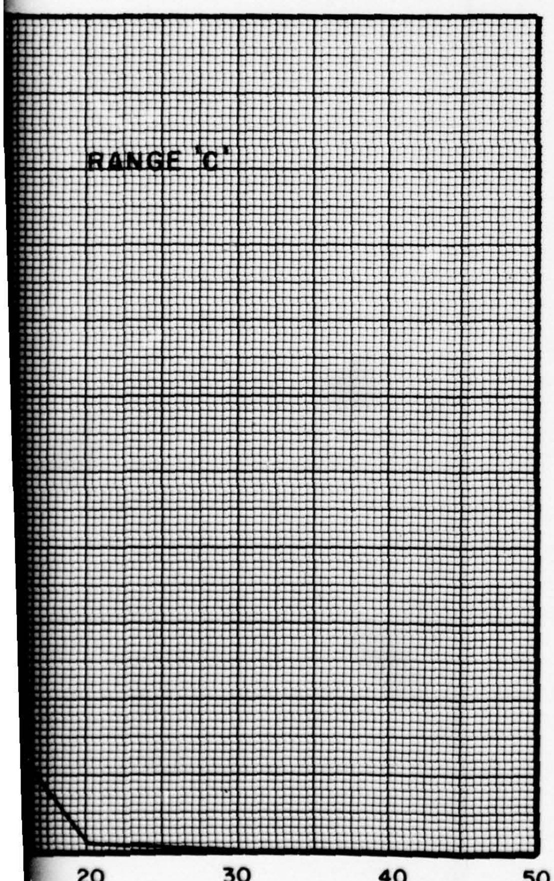



RECURRING DAMAGES IN $1000 UNITS
80000
70000
60000
50000
40000
30000
20000
10000
RANGE 'A'
RANGE 'B'
12000
10000
8000
6000
4000
2000
450
400
350
300
250
200
150
100
50
W/
0.25% 0.4
0.8
1.0
2.0
3.0
4.0
5.0
10
PERCENT CHANCE OF OCCURRENCE PER S

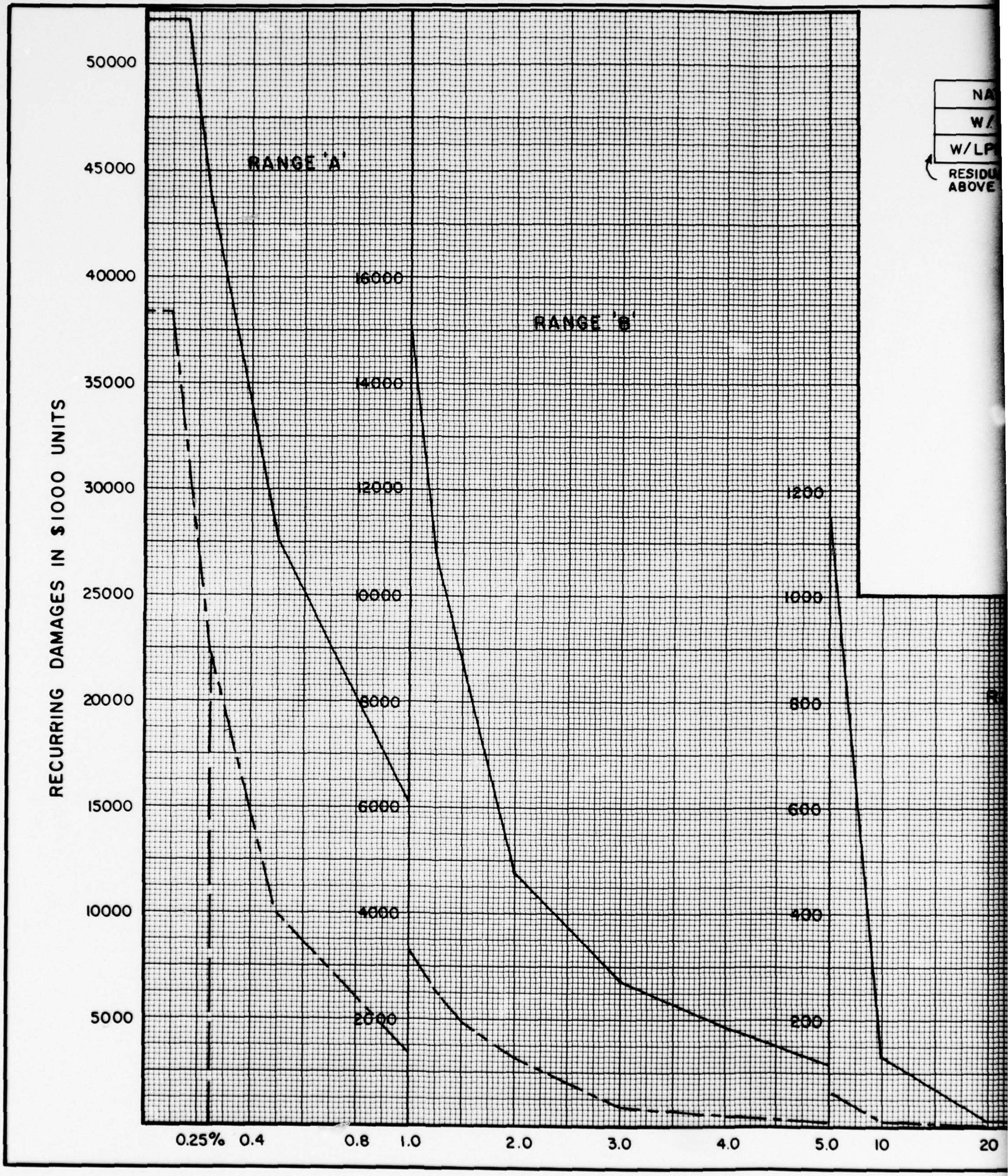
γ

| | RANGE "A" 10" = $40,000 | | | RANGE "B" 10" = $20,000 | | | RANGE "C" 10" = $5,000 | | | AVERAGE ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AREA | LOSS | BEN | AREA | LOSS | BEN | AREA | LOSS | BEN | LOSSES | BENEFITS |
| NATURAL | 9.4 | 376,000 | — | 4.7 | 94,000 | — | 3.2 | 16,000 | — | $486,000 | — |
| W/LPP (0.25 %) | 4.6 | 184,000 | 192,000 | 0 | 0 | 94,000 | 0 | 0 | 16,000 | $184,000 | 302,000 |

DAMAGE - FREQUENCY CURVE
LITTLE RIVER
WESTFIELD, MASS.
ZONE I
1978 CONDITIONS
1974 PRICE LEVEL



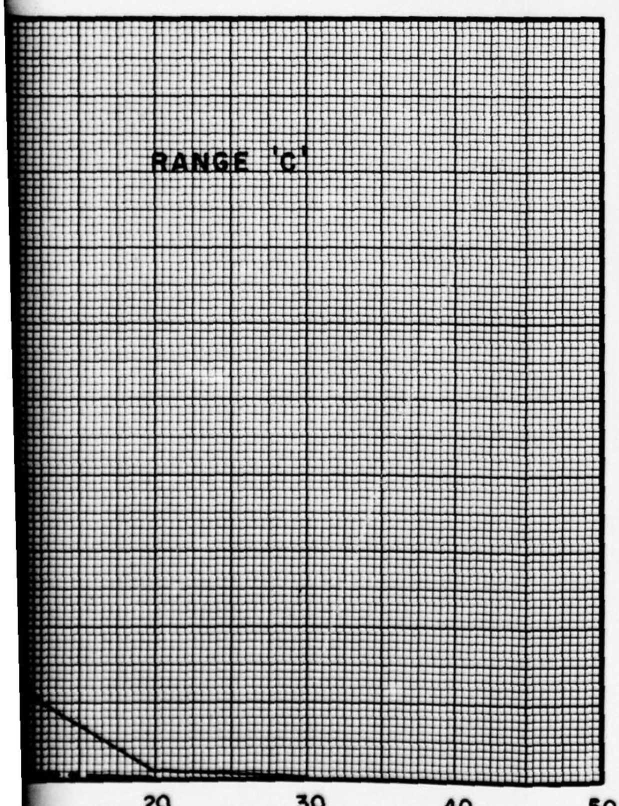

SINGLE YEAR


RANGE 'A'
RANGE 'B'
RECURRING DAMAGES IN $1000 UNITS
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
16000
14000
12000
10000
8000
6000
4000
2000
1200
1000
800
600
400
200
0.25%
0.4
0.8
1.0
2.0
3.0
4.0
5.0
10
20
W/LP
RESIDU
ABOVE

| | RANGE "A" 1□" = $20,000 | | | RANGE "B" 1□" = $20,000 | | | RANGE "C" 1□" = $20,000 | | | AVERAGE ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AREA | LOSS | BEN | AREA | LOSS | BEN | AREA | LOSS | BEN | LOSSES | BENEFITS |
| NATURAL | 16.1 | 322,000 | — | 8.3 | 166,000 | — | 1.95 | 39,000 | — | $527,000 | — |
| W/DAMS | 7.9 | 158,000 | 164,000 | 1.63 | 32,600 | 133,400 | 0.09 | 1,000 | 37,200 | 192,400 | 334,600 |
| W/LPP (0.25%) | 4.2 | 84,000 | 74,000 | 0 | 0 | 32,600 | 0 | 0 | 1,800 | 84,000 | 108,400 |

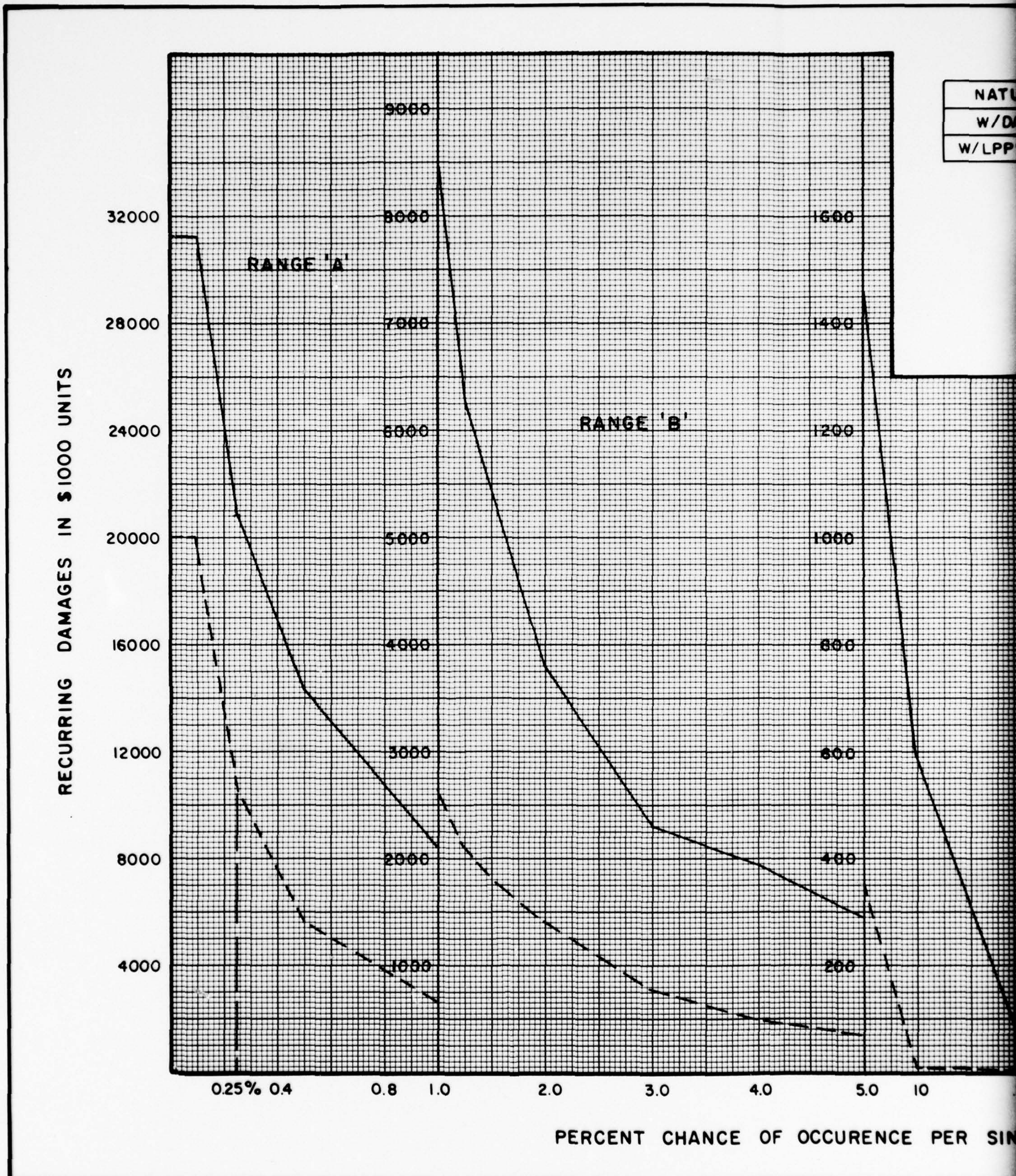
RESIDUAL LOSSES
ABOVE 400 YR EVENT

DAMAGE-FREQUENCY CURVE
WESTFIELD RIVER
WESTFIELD, MASS.
ZONE 2
1978 CONDITIONS
1974 PRICE LEVEL




PERCENT CHANCE OF OCCURRANCE
PER SINGLE YEAR

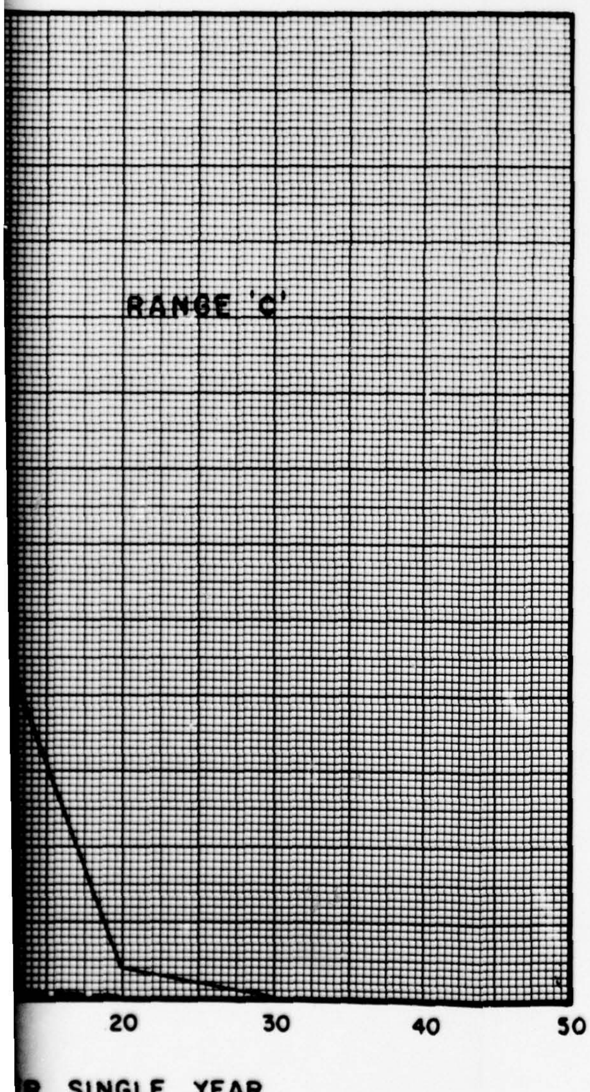
PLATE G-12

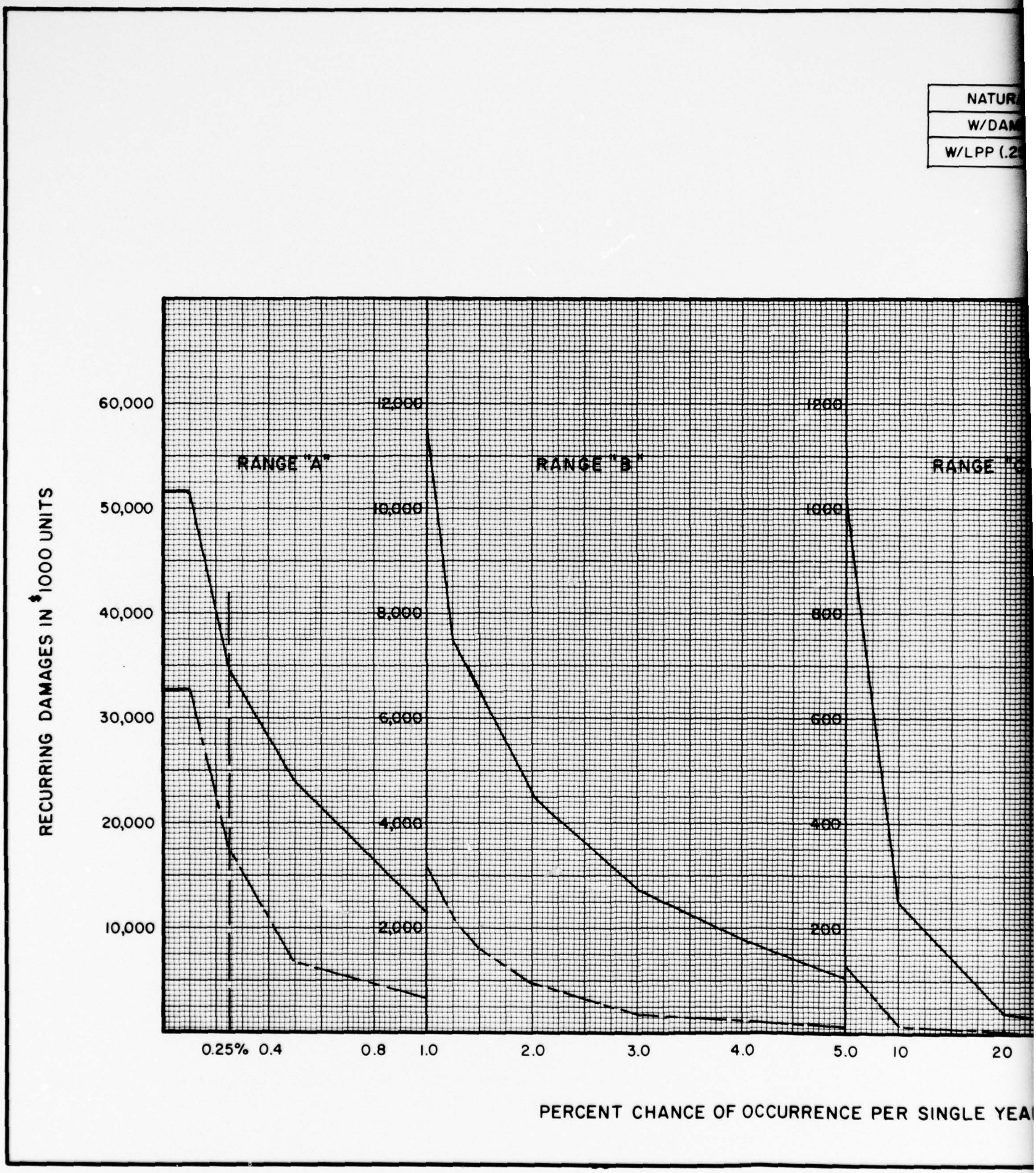

NATU
W/DA
W/LPP
RANGE 'A'
RANGE 'B'
RECURRING DAMAGES IN $1000 UNITS
32000
28000
24000
20000
16000
12000
8000
4000
9000
8000
7000
6000
5000
4000
3000
2000
1000
1600
1400
1200
1000
800
600
400
200
0.25% 0.4
0.8
1.0
2.0
3.0
4.0
5.0
10
PERCENT CHANCE OF OCCURENCE PER SIN

| | RANGE "A" 1□" = $16,000 | | | RANGE "B" 1□" = $10,000 | | | RANGE "C" 1□" = $20,000 | | | AVERAGE ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AREA | LOSS | BEN | AREA | LOSS | BEN | AREA | LOSS | BEN | LOSSES | BENEFITS |
| NATURAL | 10.8 | 172,800 | — | 12.5 | 125,000 | — | 4.3 | 86,000 | — | $383,800 | — |
| W/DAMS | 5.2 | 83,200 | 89,600 | 4.1 | 41,000 | 84,000 | 0.5 | 10,000 | 76,000 | 134,200 | 249,600 |
| W/LPP (0.25%) | 2.7 | 43,200 | 40,000 | 0 | 0 | 41,000 | 0 | 0 | 10,000 | 43,200 | 91,000 |

RESIDUAL LOSS

DAMAGE - FREQUENCY CURVE
WESTFIELD RIVER
WESTFIELD, MASS.
ZONE 3
1978 CONDITIONS
1974 PRICE LEVEL





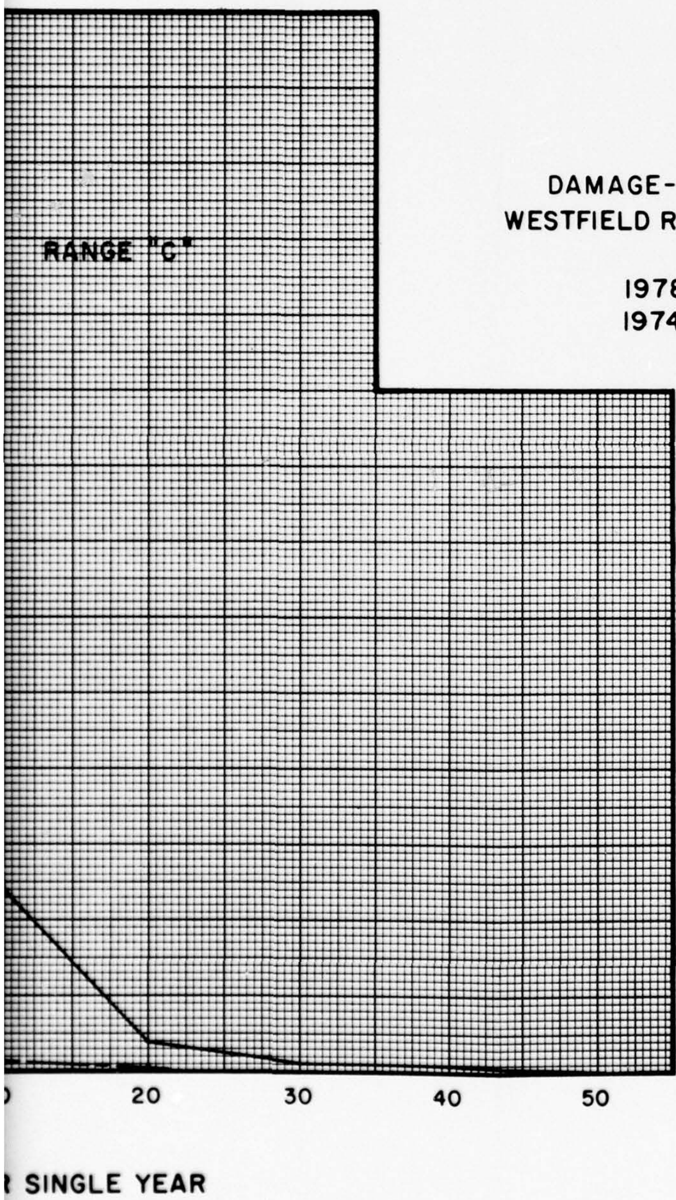
NATUR
W/DAM
W/LPP (.2
RANGE "A"
RANGE "B"
RANGE "C
RECURRING DAMAGES IN $1000 UNITS
60,000
50,000
40,000
30,000
20,000
10,000
12,000
10,000
8,000
6,000
4,000
2,000
1200
1000
800
600
400
200
0.25% 0.4
0.8
1.0
2.0
3.0
4.0
5.0
10
20
PERCENT CHANCE OF OCCURRENCE PER SINGLE YEA

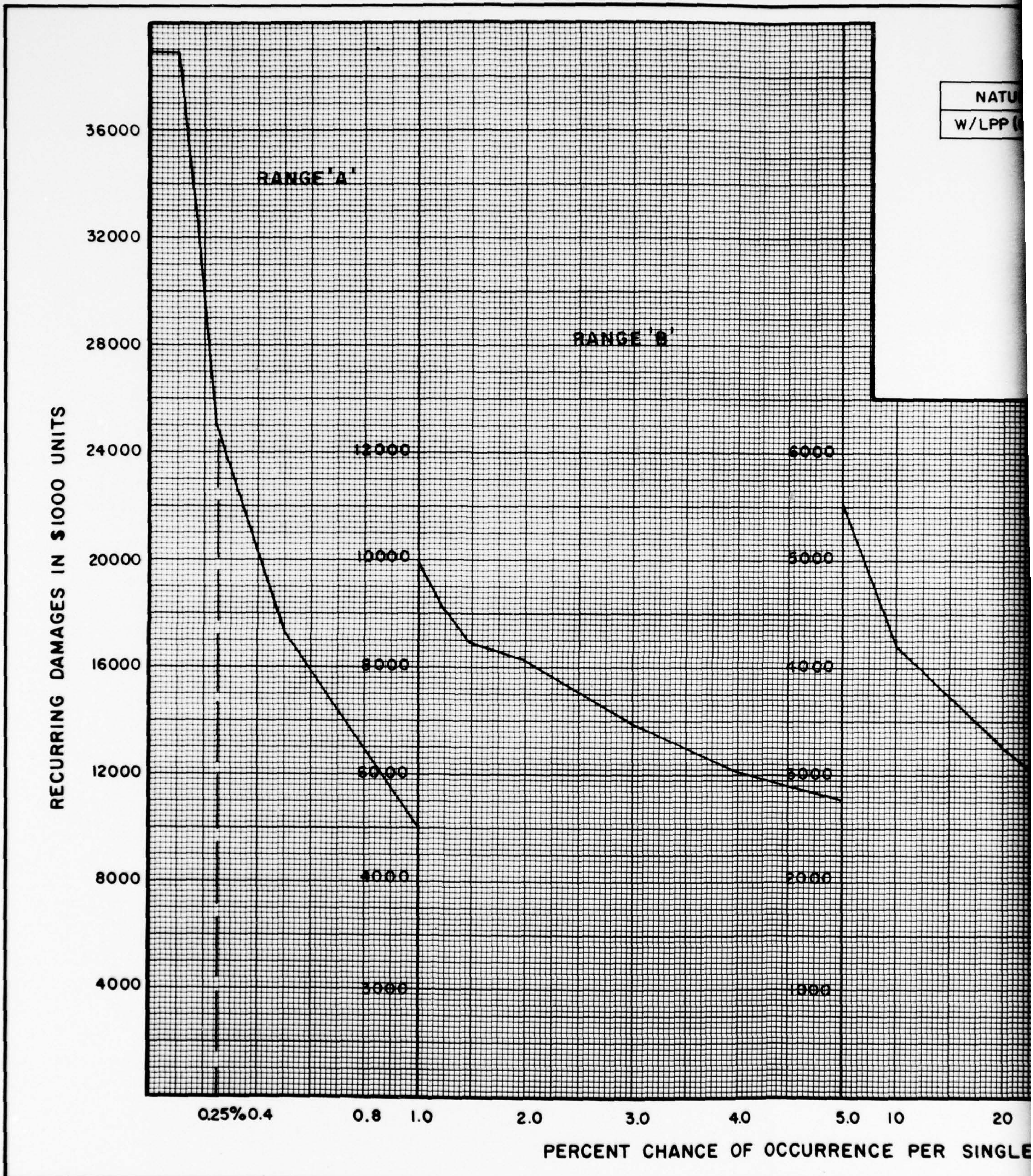
2

| | RANGE "A" 1□" = 40,000 | | | RANGE "B" 1□" = 20,000 | | | RANGE "C" 1□" = 20,000 | | | AVERAGE ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AREA | LOSS | BEN | AREA | LOSS | BEN | AREA | LOSS | BEN | LOSSES | BENEFITS |
| NATURAL | 6.96 | 278,400 | — | 7.1 | 142,000 | — | 2.4 | 48,000 | — | $468,000 | — |
| W/DAMS | 3.18 | 127,200 | 151,200 | 1.55 | 31,000 | 111,000 | 0.2 | 4,000 | 44,000 | 162,200 | 306,200 |
| W/LPP (.25 %) | 1.8 | 72,000 | 55,000 | 0 | 0 | 31,000 | 0 | 0 | 4,000 | 72,000 | 90,000 |

RESIDUAL AFTER DIKES IN PLACE

DAMAGE-FREQUENCY CURVE
WESTFIELD RIVER, WESTFIELD MASS.
ZONE 4
1978 CONDITIONS
1974 PRICE LEVEL



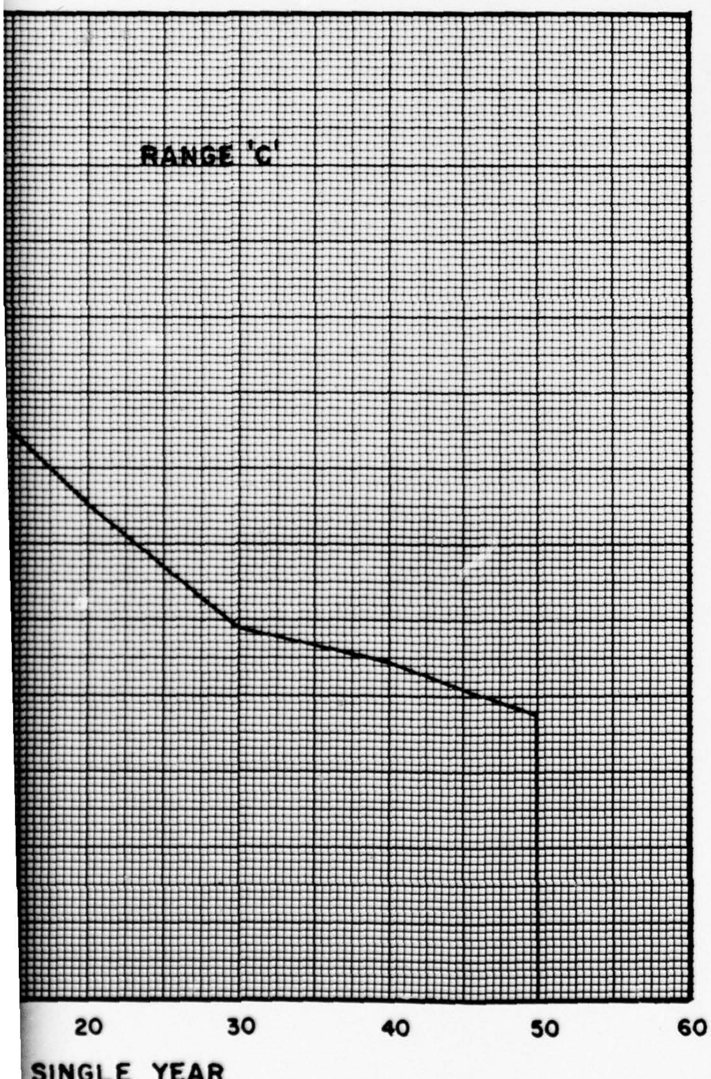


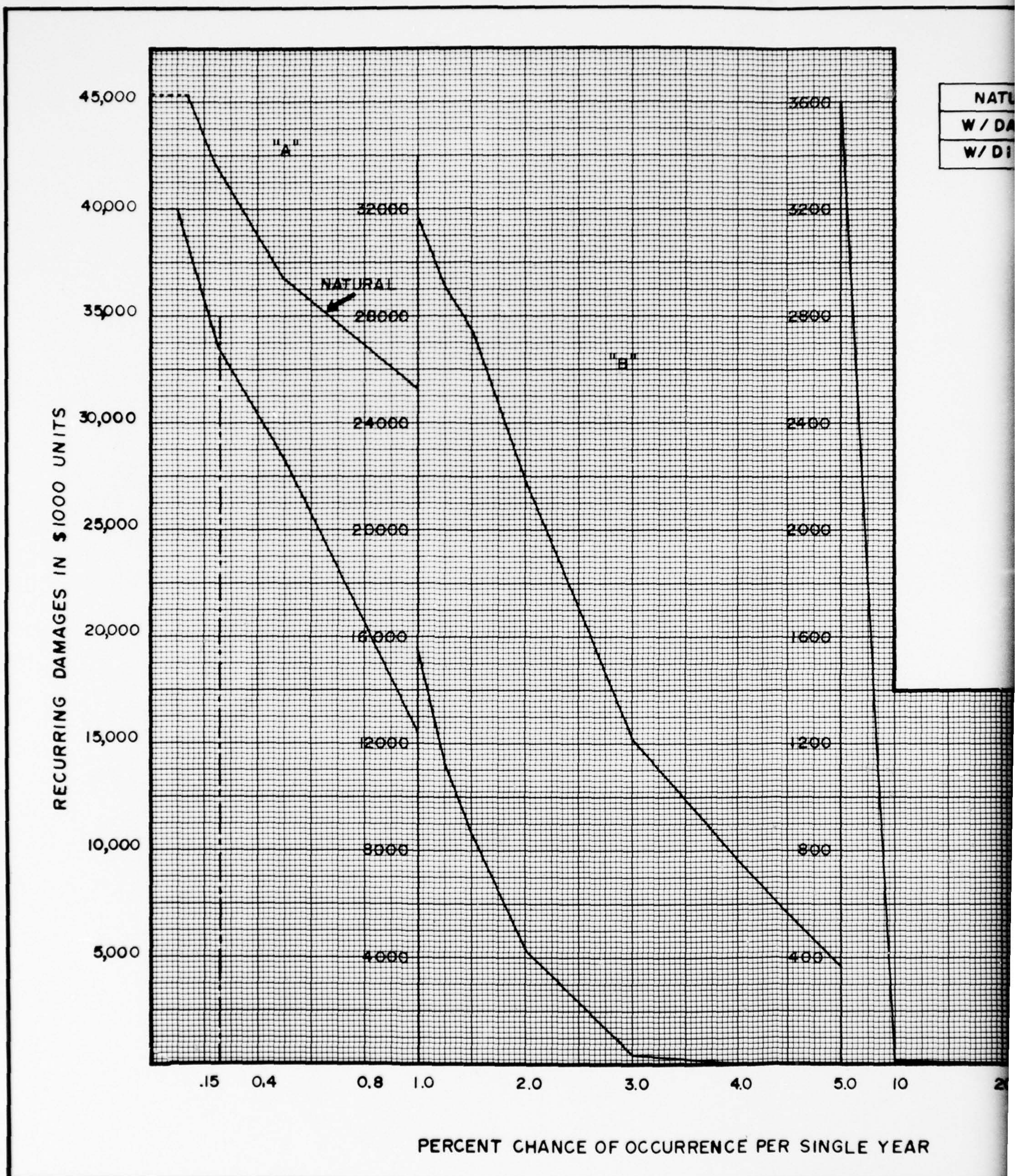
NATU
W/LPP (
RANGE 'A'
RANGE 'B'
36000
32000
28000
24000
20000
16000
12000
8000
4000
RECURRING DAMAGES IN $1000 UNITS
12000
10000
8000
6000
4000
2000
6000
5000
4000
3000
2000
1000
0.25% 0.4
0.8
1.0
2.0
3.0
4.0
5.0
10
20
PERCENT CHANCE OF OCCURRENCE PER SINGLE

2

| | RANGE "A" 1" = $16,000 | | | RANGE "B" 1" = $20,000 | | | RANGE "C" 1" = $100,000 | | | AVERAGE ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AREA | LOSS | BEN | AREA | LOSS | BEN | AREA | LOSS | BEN | LOSSES | BENEFITS |
| NATURAL | 13.0 | 208,000 | — | 14.3 | 286,000 | — | 13.4 | 340,000 | | $1,834,000 | — |
| W/LPP (0.25%) | 5.4 | 86,400 | 121,600 | 0 | 0 | 286,000 | 0 | 0 | 340,000 | 86,400 | 1,747,600 |

DAMAGE-FREQUENCY CURVE
LITTLE RIVER
WESTFIELD, MASS.
ZONE 5
1978 CONDITIONS
1974 PRICE LEVEL





"A"
"B"
NATURAL
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
32000
28000
24000
20000
16000
12000
8000
4000
3600
3200
2800
2400
2000
1600
1200
800
400
RECURRING DAMAGES IN $1000 UNITS
.15
0.4
0.8
1.0
2.0
3.0
4.0
5.0
10
PERCENT CHANCE OF OCCURRENCE PER SINGLE YEAR

| | RANGE "A" 1□" = $20,000 | | | RANGE "B" 1□" = $40,000 | | | RANGE "C" 1□" = $40,000 | | | AVERAGE ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AREA | LOSS | BEN | AREA | LOSS | BEN | AREA | LOSS | BEN | LOSSES | BENEFITS |
| NATURAL | 19.0 | 380,000 | | 14.85 | 594,000 | | 2.2 | 88,000 | | 1,062,000 | |
| W/DAMS | 14.4 | 288,000 | 92,000 | 2.7 | 108,000 | 486,000 | 0 | 0 | 88,000 | 396,000 | 666,000 |
| W/DIKE | 4.76 | 95,200 | 192,800 | 0 | 0 | 108,000 | 0 | 0 | 0 | 95,000 | 300,800 |

DAMAGE FREQUENCY CURVE
WESTFIELD RIVER, WESTFIELD, MA.
ZONE 6
1978 PRICE LEVEL

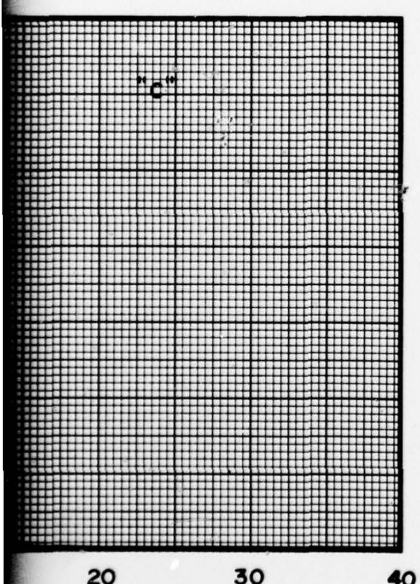
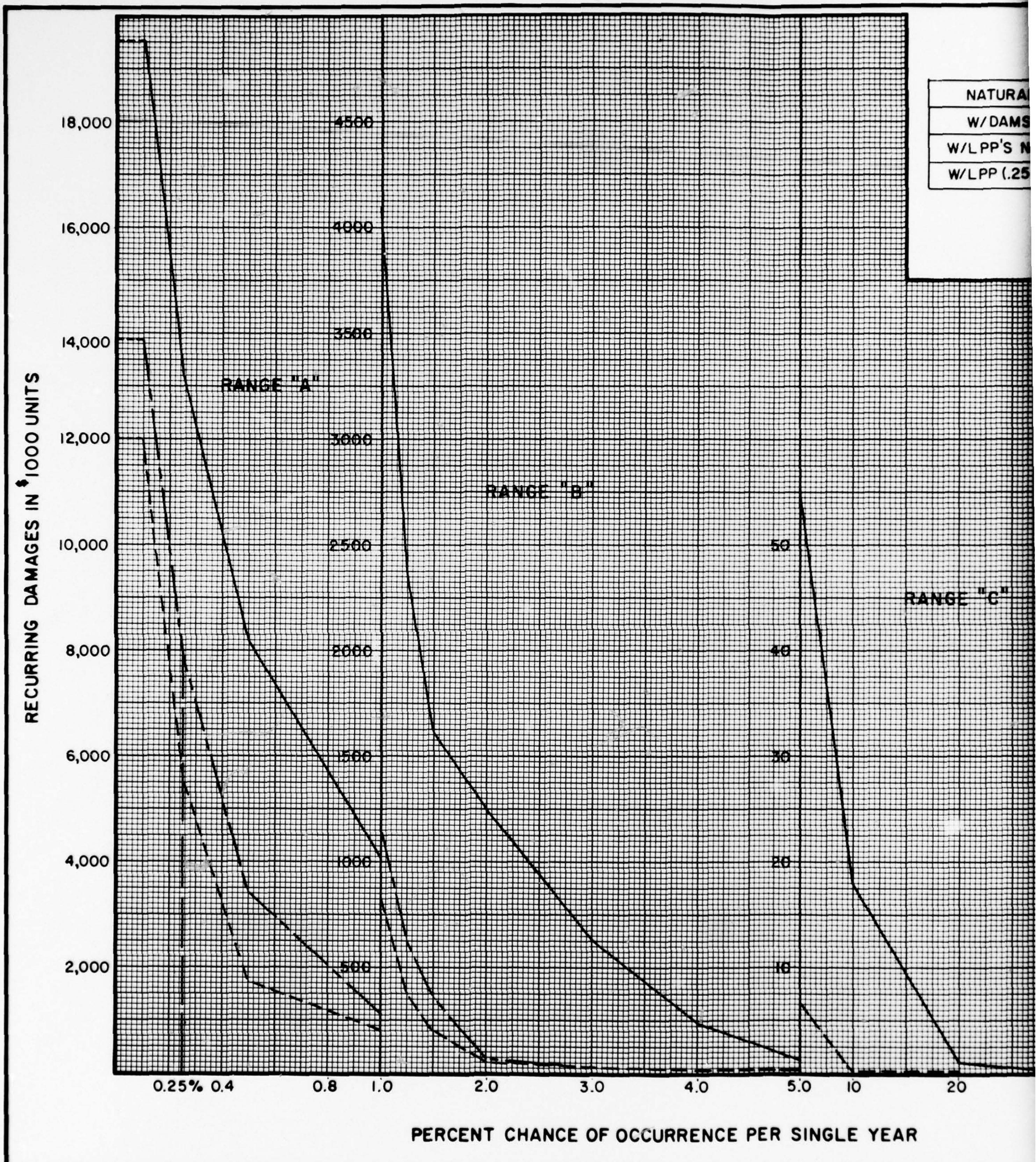
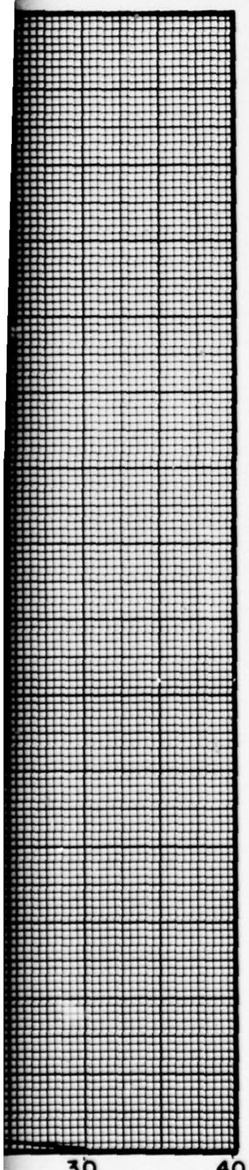



PLATE G-16

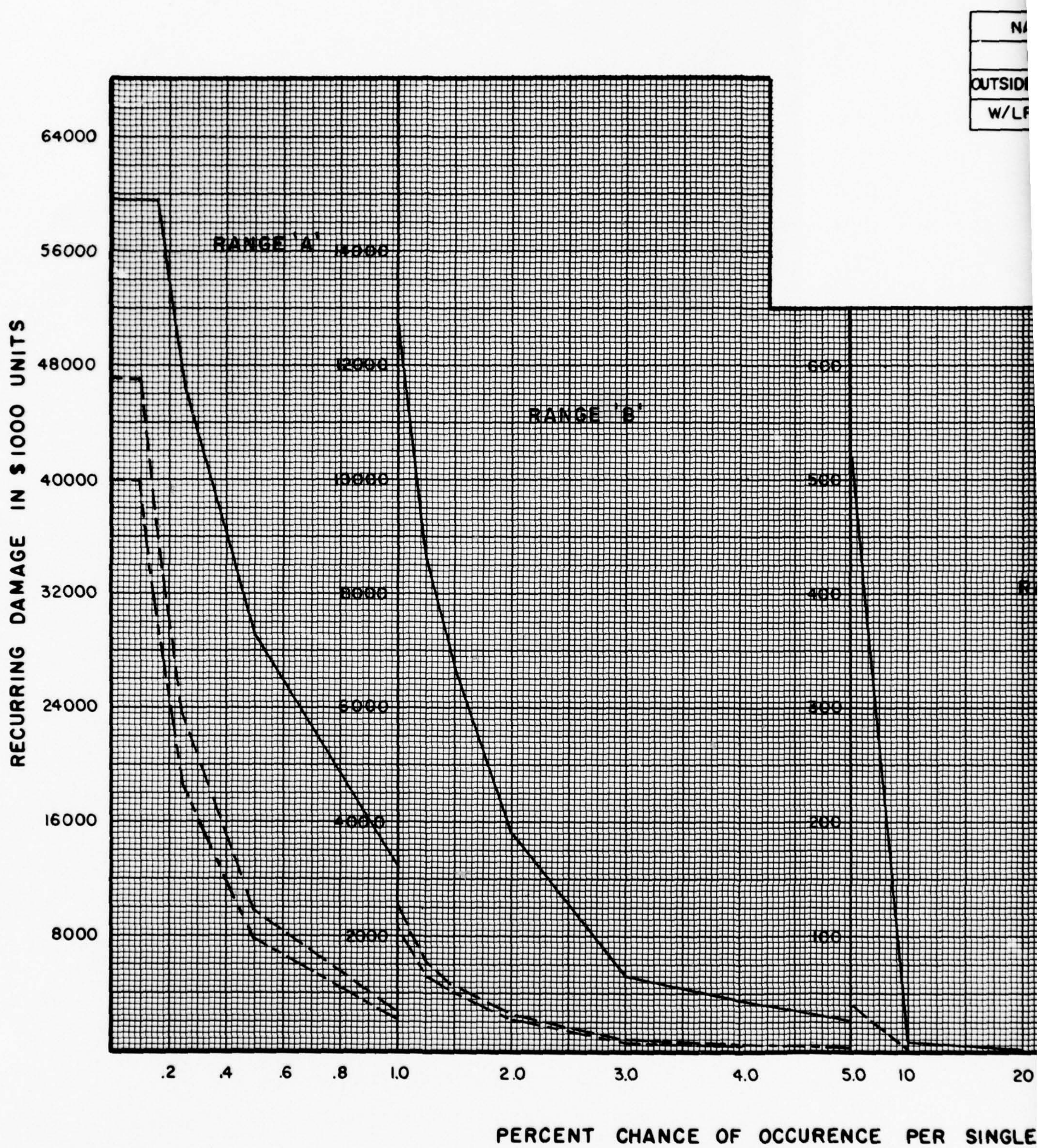

NATURA
W/DAMS
W/LPP'S N
W/LPP (.25
RANGE "A"
RANGE "B"
RANGE "C"
RECURRING DAMAGES IN $1000 UNITS
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
4500
4000
3500
3000
2500
2000
1500
1000
500
50
40
30
20
10
0.25% 0.4
0.8
1.0
2.0
3.0
4.0
5.0
10
20
PERCENT CHANCE OF OCCURRENCE PER SINGLE YEAR

2

| | RANGE "A" 1□" = $8,000 | | | RANGE "B" 1□" = $5,000 | | | RANGE "C" 1□" = $1,000 | | | AVERAGE ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AREA | LOSS | BEN | AREA | LOSS | BEN | AREA | LOSS | BEN | LOSSES | BENEFITS |
| L | 12.7 | 101,600 | — | 7.1 | 35,500 | — | 2.8 | 2,800 | — | 139,900 | — |
| S | 5.1 | 40,800 | 60,800 | 0.9 | 4,500 | 31,000 | 0.2 | 200 | 2,600 | 45,500 | 94,400 |
| NEG. | 7.0 | 56,000 | -15,200 | 1.2 | 6,000 | -1,500 | 0.2 | 200 | — | 62,200 | -16,700 NEGS |
| 5 %) | 3.16 | 25,280 | 15,520 | 0 | 0 | 4,500 | 0 | 0 | — | 25,280 | 20,220 |




DAMAGE - FREQUENCY CURVE
POWDER MILL BROOK AND WESTFIELD RIVER
WESTFIELD, MA.,
ZONE 7A - ABOVE
1978 CONDITIONS
1974 PRICE LEVEL

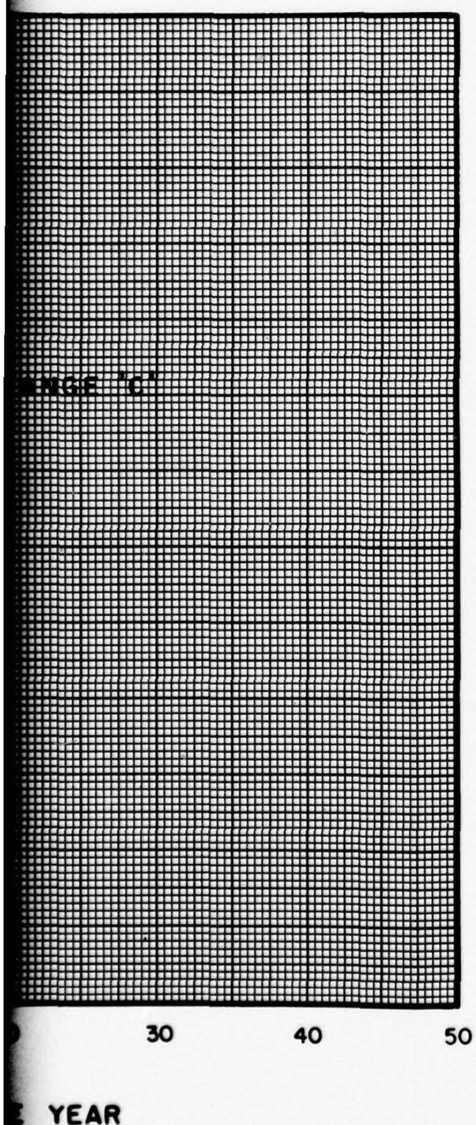


RECURRING DAMAGE IN $1000 UNITS
64000
56000
48000
40000
32000
24000
16000
8000
RANGE 'A'
14000
12000
10000
8000
6000
4000
2000
RANGE 'B'
600
500
400
300
200
100
.2
.4
.6
.8
1.0
2.0
3.0
4.0
5.0
10
20
PERCENT CHANCE OF OCCURENCE PER SINGLE
NA
OUTSIDE
W/LF

| | RANGE "A" 1 " = $32,000 | | | RANGE "B" 1 " = $20,000 | | | RANGE "C" 1 " = $10,000 | | | AVERAGE ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AREA | LOSS | BEN | AREA | LOSS | BEN | AREA | LOSS | BEN | LOSSES | BENEFITS |
| ATURAL | 10.8 | 345,600 | — | 5.7 | 114,000 | — | 1.35 | 13,500 | — | $473,100 | — |
| DAMS | 4.36 | 139,500 | 206,100 | .76 | 15,200 | 98,000 | .09 | 900 | 12,600 | 155,600 | 317,500 |
| E PROT AREA | 5.1 | 163,200 | -23,700 | .888 | 17,760 | -2,560 | .09 | 900 | — | 181,860 | -26,260 |
| PP (.25%) | 2.59 | 82,880 | 56,620 | 0 | 0 | 15,200 | 0 | 0 | 900 | 82,880 | 72,720 |

DAMAGE - FREQUENCY CURVE
WESTFIELD RIVER AND POWERMILL BROOK
WESTFIELD, MA.

ZONE 7B - MODIFIED
1974 PRICE LEVEL
1978 CONDITIONS




NOT PROT: MUTTER'S JUNKYARD
LEVINSKI'S JUNKYARD
N.E. CONCRETE PIPE
ROMANSKI'S FARM
2/3's OF GUIDA FARM

**KEY**

—— NATURAL

– – – WITH LITTLEVILLE & KNIGHTVILLE DAMS

— — — OUTSIDE PROJECTED AREA

PLATE G-18

# SECTION H

## DIVISION OF PLAN RESPONSIBILITIES

SECTION H

# *DIVISION OF PLAN RESPONSIBILITIES*

TABLE OF CONTENTS


| Item | Page |
|---|---|
| EXISTING POLICIES | |
| COST APPORTIONMENT | H-1 |
| FEDERAL RESPONSIBILITIES | H-2 |
| NON-FEDERAL RESPONSIBILITIES | H-2 |
| PROPOSED POLICIES | |


LIST OF TABLES


| No. | Title | Page |
|---|---|---|
| H-1 | COMPARISON OF FEDERAL AND NON-FEDERAL FIRST COSTS UNDER THE EXISTING AND PROPOSED WATER RESOURCE POLICIES | H-4 |

## SECTION H

# DIVISION OF PLAN RESPONSIBILITIES

This section presents the responsibilities and cost apportionment between Federal and non-Federal interests that would be required for implementation of the selected plan. At the present time this apportionment is based on Federal legislation and administrative policies governing local flood protection projects. However, the President has proposed cost sharing reforms which would change the amount of non-Federal contributions if this legislation is passed. For this reason, this section is divided into two sub-sections; the first describes the division of plan responsibilities under existing policies and the second describes these responsibilities under policies proposed by the President. The differences between these policies is also shown on Table H-1 which follows these sub-sections.

It should also be pointed out that while non-structural measures are not requirements of the selected plan, local interests should consider and adopt such non-structural measures as necessary to protect life and property outside the protected area. A discussion of non-structural measures is given in Section I of this Appendix. The responsibility for implementing non-structural measures is non-Federal, although technical advice is available from Federal agencies.

COST APPORTIONMENT

Under these policies the Federal government would be responsible for all flood control construction costs. Non-Federal interests would be required to furnish all lands and rights-of-way and damages, including relocations, required by the plan. Non-Federal interests also would bear the cost of operating and maintaining project features after construction in accordance with Federal requirements. Total project costs are currently estimated at $39,100,000.

## FEDERAL RESPONSIBILITIES

The presently estimated Federal share of the total first costs of the selected local protection plan is $34,300,000.

The Federal government will also design and construct the local protection system entirely at Federal cost except for the specified items of local cooperation. After construction is completed, the project will be turned over to the city of Westfield for operation and maintenance.

## NON-FEDERAL RESPONSIBILITIES

The presently estimated non-Federal share of the total first cost of the selected local protection plan is $4,800,000. In addition, non-Federal interests would be required to operate and maintain the project after completion at an estimated average annual cost of $20,000. The specific items of local cooperation are described as follows:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction and subsequent maintenance of the project (currently estimated at $3,600,000).

b. Hold and save the United States free from damages due to construction, operation and maintenance of the works, except damages due to the fault or negligence of the United States or its contractors.

c. Maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of the Army (currently estimated at $20,000 annually).

d. Provide without cost to the United States all alterations and replacements of existing utilities (currently estimated at $1,200,000).

e. Prescribe and enforce regulations to prevent encroachment on both the improved and unimproved channels and the ponding areas, and manage all project related functions to preserve capacities for local drainage as well as for project functions.

f. Comply with the provisions under Sections 210 and 305 of Public Law 91-646, 91st Congress, approved January 2,1971, entitled "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970".

In accordance with the Massachusetts General Laws, the formal assurances of local cooperation also will be requested through the Commonwealth of Massachusetts before any construction of the proposed project is undertaken.

# *PROPOSED POLICIES*

In his June 1978 message to Congress on Water Policy, President Carter proposed cost-sharing reforms which would change the amount non-Federal contributions for Federal water resource programs. These recommended changes would include a cash contribution from benefiting states of 5 percent of the first costs of construction assigned to nonvendible (flood control) project purposes and 10 percent of the first costs assigned to vendible project purposes. Application of this policy to the selected plan would require the Commonwealth of Massachusetts to contribute an estimated $1,955,000 (5 percent of 39,100,000) to the project.

The President also proposed that the present cost-sharing requirement for flood damage prevention projects be modified to require a cash or in-kind contribution equal to 20 percent of the project first costs. In the case of local protection type projects, this cash and/or in-kind contribution includes the existing requirement that local interests provide without cost to the United States all lands, easements, rights-of-way, and relocations or replacements necessary for construciton of the project. Application of this policy to the selected plan would require that non-Federal interests make, in addition to the State's 5% contribution, a cash or in-kind contribution of approximately $7,820,000 (20 percent of $39,100,000). Inasmuch as the calculated in-kind cost are presently $4,800,000, the effect of this policy is to require $3,020,000 in cash as well.

TABLE H-1

COMPARISON OF FEDERAL AND NON-FEDERAL FIRST COSTS
UNDER THE EXISTING AND PROPOSED WATER RESOURCE POLICIES

| | EXISTING POLICIES | PROPOSED POLICIES |
|---|---|---|
| Federal Share | $34,300,000 | $29,325,000 |
| Non-Federal Share | 4,800,000 | 9,775,000* |
| TOTAL | $39,100,000 | $39,100,000 |

*Includes the 5% ($1,955,000) and 20% ($7,820,000) non-Federal contributions.

# SECTION I

## NON-STRUCTURAL SOLUTIONS

SECTION I

# NON-STRUCTURAL SOLUTIONS

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# SECTION I

# NON-STRUCTURAL SOLUTIONS

Non-structural measures for solving the flood problem within the city of Westfield could be categorized into regulation, management, subsidization, acquisition, and miscellaneous classes. Regulation could include zoning, channel lines, building codes, health regulations, and flow regulations. Management could include flood forecasting, temporary evacuation, flood proofing, land use planning, and land treatment. Subsidization could include tax relief, flood insurance, and incentive payments (such as for purchase of land for open space and natural storage). Acquisition could provide for either the outright purchase of land, or the purchase of easements and options for land use. Other categories include tax adjustment, legal controls such as deed restrictions, and long-range actions such as research into improved management techniques, and the education of all segments of society to the danger of floods and the various means of preventing them.

## REGULATORY MEASURES

The most effective regulatory actions would be zoning and building codes. Zoning would prevent additional flood damages by limiting flood plain development to those types of features least subject to flood damages. Such zoning must be strong enough to prevent incompatible development yet definitive enough to permit wise development on the flood plain. One factor limiting the effectiveness of local zoning is the probability of changes being made to the ordnances over a period of time, resulting in continuing development on the flood plain. Building codes could require the sensible use of flood prone areas by establishing the type of buildings, elevation of doors and windows, road elevations, and placement of utilities. However, changes to and variances from the building codes would result in structures not adequately protected from floods.

# MANAGEMENT MEASURES

The management actions that could be effective in Westfield would be flood forecasting and temporary evacuation. Temporary flood proofing measures could be useful if adequate warning is received. The success of these actions depends upon adequate long-range planning and the education of the population of the flood plain. The Weather Bureau provides flood warnings which serve as a basis for these emergency measures. If timely warnings were provided and enough labor was available, alterations could be carried out to minimize flood damages to residential, commercial, industrial and public buildings. In addition to the raising of furniture, materials, supplies and records, permanent or semi-permanent measures may be carried out. These could include bricking-in or otherwise structurally closing and sealing doors and windows and other openings; installing cut-off valves on sewers; relocating electric circuits above expected flood levels and similar measures that would protect buildings and/or their contents from flood waters.

Since the Westfield River watershed has such rapid runoff, the time of concentration at the city of Westfield being only about eight hours following heavy precipitation, there is very little time for last-minute flood proofing. Under these conditions, the most likely course of management action would include flood forecasting, development of plans at the city and individual levels for whatever flood proofing measures are possible in the few hours available, and temporary evacuation of the population to previously-arranged facilities. The cost of developing these plans and providing standby facilities would be relatively inexpensive and the human impact less than if the city was unprepared.

Other management actions that could be followed are land use planning and land treatment. These are long-range procedures to reduce the effect of floods which may occur after the plans have been implemented. Land use planning could reduce flood damages and allow uses which would experience relatively little damage from flooding. Land treatment is essentially the correct management of watershed land to control the variety of conditions that contribute to flooding within the watershed.

A brief summary of the major techniques of land treatment follows. (1) In forested flood plains, dead and fallen timber, dumping grounds, and other debris should be removed to prevent damage downstream during floods. Live trees in danger of falling into waterways or capable of restricting flow should be removed by thinning operations. (2) Areas of idle open land should be reforested. (3) Management of forest land, particularly that in private ownership, should be improved. This includes approved harvesting methods, especially the location of logging roads, and improvement of the overall hydrologic conditions through intensification of fire prevention and control measures, improved silvicultural practices, and the exclusion of grazing. This type of management will increase the infiltration of precipitation and retard storm runoff. Under certain conditions it can provide a significant degree of flood prevention in downstream watersheds. (4) In drainage areas which do not contain sites with physical potential for structural development, land treatment can provide a significant degree of protection under some conditions. It is apparent that land treatment procedures could be considered as supplements to structural solutions. (5) Management and land treatment above flood control structures could be intensified to reduce erosion and result in subsequent reduction of sedimentation at reservoirs, thereby prolonging the effective life of these facilities.

Since approximately 497 square miles of watershed lie upstream of the city of Westfield, these land treatment techniques would require a long term cooperative effort between Westfield, the towns upstream, and the agencies which control the various state forests and conservation areas in the upper part of the watershed. Conversely, the city would be expected to manage the land treatment techniques within Westfield to reduce the effect of flooding in towns downstream. A long range plan, coordinated between all communities, the state, and regional and Federal agencies would be required for land treatment techniques to be effective in reducing future flood damages in the watershed.

## *SUBIDIZATION MEASURES*

Subsidization in the form of tax relief, flood insurance or incentive payments may be used to insure that wise use of flood plain lands continues. Tax relief could be applied to the flood plain areas presently occupied by farms, forests, open space or similar land use which would be only slightly affected by floods. The continuance of

these land uses will prevent additional flood damages and could assist in reducing downstream flood stages. The value of the present use of this land could be reflected in the assessment of the properties. Another use of tax relief could be applied toward the relatively few properties that would be outside the proposed diking system. Their continued exposure to future floods could be mitigated by a lower property assessment. The lower assessment would result in slightly less tax revenue to the city, but this small loss could be balanced by a very minor increase in the assessment of the approximately 2,700 properties that would be protected by the proposed protection project.

Flood insurance is another form of subsidy. The flood insurance program requires strict regulation of development in flood-prone areas, thereby reducing additional flood damages. At the same time the insurance program would provide some measure of relief to properties already occupying the flood plain.

Incentive payments are a form of subsidy similar to tax relief in that they can be used to encourage the wise use of flood plains. Federal grants are available to assist communities in acquiring flood plain land to preserve it as open space. This method should be considered to reinforce zoning and acquisition programs to control the undeveloped areas within the flood plain of the city.

## *ACQUISTION*

Acquisition can be accomplished by either the outright purchase of land, or the purchase of easements and options for land use. Acquisition can be an effective means of minimizing future flood damages since it controls the use of the acquired land. Land acquired within the flood plain could be restricted to those uses which would experience little or no damage from floods, while acquired land upstream could be retained for use as runoff-retarding wetlands or similar uses which would not increase downstream flood stages.

One example of acquisition as an effective means of flood control is the Charles River Watershed Natural Valley Storage Project. A study conducted by the Corps of Engineers to determine the optimum means of controlling future flood damages in the highly urbanized lower watershed in suburban Boston concluded that Federal acquisition and perpetual protection of 17 crucial natural valley storage areas

totalling some 8,500 acres would provide the least-cost solution to downstream flooding. The acquisition program has been funded, and the purchasing of land and easements is underway. This non-structural solution is a significant component of the flood control program within the Charles River Watershed.

The acquisition program was effective because the Charles River has a flat gradient and much of the upper watershed contains swamps, marshes and wet meadows which act as detention areas and slowly release stored water into the stream. The 1955 flood of record in the Charles River Watershed was much less damaging than it would have been had different hydrologic conditions existed. Instead of the flood waters pouring downstream all at once and causing high flood stages, the wetlands stored about 50,000 acre feet, the last of which was released a full month after hurricane Diane had passed.

While acquisition of property within the flood plain of Westfield could be a useful procedure for reducing future flood damages, the acquisition of land in the watershed above the city does not appear to be worthwhile because of the very rapid runoff characteristics of the Westfield River Watershed. Prohibiting development in the nearly 500 square mile drainage area above the city would have very little effect on these runoff characteristics. Accordingly, acquisition would appear to be applicable only to properties within the flood plain of the city of Westfield.

The success of the acquisition program, as with zoning, building codes, tax relief, incentive payments and similar programs, depends upon the determination of the public agencies responsible for the administration of the acquired lands to make reasonable decisions concerning future public use.

## *FLOOD PROOFING*

Flood proofing of structures and facilities would be expensive, would provide limited protection, and would also be a local responsibility. In addition, flood proofing of homes and commercial, industrial and public buildings is usually practical to protect against flood stages up to the first floor sill. Flood proofing above this elevation is impractical as typical walls and doors would leak unless major modifications are undertaken.

Typical flood proofing techniques include "bricking-in" cellar windows and other openings, and waterproofing from ground level up to the sill. Additional protection could be provided by applying a waterproof coating to the cellar floor and the inside of the foundation walls. In the case of older foundations or those in poor condition, protection could be obtained by excavating around the outside of the foundation and placing a concrete wall adjacent to the existing foundation, thereby strengthening and sealing the original foundation wall. Other possibilities include pouring a new cellar floor over the existing one to stop inflow through floor cracks or installation sump pumps to remove water which has entered the building. Another form of flood proofing is to build a dike or wall around a property, the height being adequate to protect against anticipated flood stages, and to provide a pump to remove interior runoff. This could be used to protect an industrial plant, municipal facility such as a pumping station, a portion of a neighborhood or other location where the cost would be justified.

Inasmuch as flood proofing of individual structures is generally effective only up to the first flood elevation and anticipated flood stages would exceed this elevation in most cases, this alternative would not provide adequate protection for the city of Westfield. However, some properties located on the fringe of the floodway or in other areas where flood stages would not affect the first floor, could benefit by flood proofing. In addition, individual dikes or walls around some structures may be found justified.

## *OTHER MEASURES*

Other non-structural solutions may be considered. One that has considerable long-term potential is an educational program to make the public aware of flood dangers and the means of preventing them. A program of both adult education and public school courses in conservation and water resources would increase public awareness and involvement in such programs. The result of public participation could be a comprehensive program which considers the total water resources of the area and provides a flood protection program best suited to the particular conditions of the city. Combined structural and non-structural solutions which improve the social, economic and environmental aspects of the local society also could be proposed. The education program could be somewhat informal, if desired, and oriented specifically

toward the problems of Westfield and nearby communities. This portion of the program could be handled by local civic organizations and the city. Additional segments of the program could be provided by state and Federal agencies.

Research is being conducted to determine the relationship between various watershed management techniques, the associated runoff rates, and the downstream flood stages which result from various combinations of terrain and management procedures. While some results of the research programs will become available soon after initiation, the programs are long-range and will provide continuing inputs for those interested in watershed management. Local civic groups and interested towns could coordinate a research program with the city of Westfield. However, the real worth of research can be realized only if the adminstration of the recommended techniques are not compromised for purposes of local expediency.

The legal aspects associated with the several regulatory, management, subsidization, acquisition and other actions which may be recommended will have to be considered and resolved before any action is implemented. Since non-structural flood control measures may encroach the properties, uses and rights of many citizens not directly affected by the need for such actions, it could lead to resentment of, and lack of cooperation with, recommended programs and ultimate failure of non-structural programs. Therefore, regardless of any future legislative or judicial actions that may be implemented, it would be advisable to consider the rights of the individual as well as the larger social needs, not only because of the moral obligation but also for the practical consideration of long-range success for the program.

Relocating structures, towns or parts of a city to a location safe from anticipated flood stages often is termed a "non-structural" solution. While such action may not result in construction of a dam or a local protection project, the relocation of buildings, roads, and utilities is obviously a structural undertaking. The social, environmental and economic effects of these relocations could be considerable, and possibly greater than might result from the more common structural solutions.

In the specific situation in Westfield, the costs and impacts of relocating approximately 2,700 buildings with related utilities and roads are so large as to be impractical. Relocation on this scale would have a massive social effect; Westfield would become a completely different city at great financial expense and with a considerable effect on the environment. Therefore, relocation as an alternative is neither practical nor cost effective, and should not be considered as a practical solution to flooding problems.

## ASSESSMENT OF NON-STRUCTURAL MEASURES

While not all the preceding techniques can be considered practical when applied to the flood problem at Westfield, a combination of methods could be implemented by the city to provide a non-structural plan for flood protection. The obvious limitation of a non-structural plan is that it cannot prevent flood waters from inundating facilities already located in the flood plain. However, such a plan could minimize the effect of flooding by preventing further encroachment into the flood plain, and reduce damage by early warning, evacuation and flood proofing.

Zoning, building codes, flood insurance regulations and other measures which prevent further encroachment into the flood plain are a local responsibility. There would be no direct cost for implementing these measures, but there may be an indirect economic loss that could be caused by limiting development in flood plain areas. The city must make these decisions relative to the balance between growth and flood protection.

Some of these decisions have already been made. The 1976 Westfield Planning Report recommends that vacant land in the flood plain remain essentially in its present state, that is, no buildings or facilities prone to flood damage would be allowed. This vacant land could ultimately be used for agriculture, open space, or recreation.

## RECOMMENDED NON-STRUCTURAL PLAN

It is strongly recommended that the city develop and implement a local emergency preparedness plan to reduce the threat to loss of life and also to reduce damage to property. A timely warning would allow the evacuation of people, the removal of the contents of some buildings, and the temporary flood proofing of some structures and facilities. This emergency preparedness plan could be implemented at very little cost, since it could be developed and carried out by existing official city organizations and civic groups.

WESTFIELD LOCAL PROTECTION
WESTFIELD RIVER
WESTFIELD, MASSACHUSETTS

# PERTINENT CORRESPONDENCE

# APPENDIX 2

WATER RESOURCES INVESTIGATIONS

APPENDIX 2

# *PERTINENT CORRESPONDENCE*

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| Exhibit No. | Agency | Letter Dated |
|---|---|---|
| 1 | U.S. Dept. of Interior Office of the Secretary | 13 Feb 1979 |
| 2 | Dept. of Health, Education and Welfare Region 1 | 9 Feb 1979 |
| 3 | Dept. of Health, Education and Welfare Area Office | Feb 1979 |
| 4 | U.S. Dept. of Interior Fish and Wildlife Service | 6 Feb 1979 |
| 5 | Commonwealth of Massachusetts Office of the Secretary | 22 Nov 1978 |
| 6 | U.S. Dept. of Interior Heritage Conservation and Recreation Service | 3 Oct 1978 |
| 7 | Commonwealth of Massachusetts Dept. of Environmental Quality Engineering | 4 Apr 1978 |
| 8 | U.S. Dept. of Interior Heritage Conservation and Recreation Service | Mar 1978 |
| 9 | U.S. Dept. of Interior Fish and Wildlife Service | 2 Dec 1977 |
| 10 | Commonwealth of Massachusetts Executive Office of Environmental Affairs | 20 Sept 1977 |
| 11 | U.S. Dept. of Interior Fish and Wildlife Service | 15 Aug 1977 |
| 12 | Commonwealth of Massachusetts Division of Fisheries and Game | 29 June 1977 |
| 13 | Westfield River Watershed Association, Inc. | 27 June 1977 |

| Exhibit No. | Agency | Letter Dated |
|---|---|---|
| 14 | Commonwealth of Massachusetts<br>Executive Office Environmental Affairs | 24 June 1977 |
| 15 | Town of West Springfield, Massachusetts<br>Board of Selectmen | 24 June 1977 |
| 16 | U.S. Dept. of Agriculture<br>Soil Conservation Service | 24 June 1977 |
| 17 | U.S. Environmental Protection Agency<br>Region I | 21 June 1977 |
| 18 | Commonwealth of Massachusetts<br>Dept. of Public Works | 10 June 1973 |
| 19 | Commonwealth of Massachusetts<br>Water Resources Commission | 6 June 1977 |
| 20 | Commonwealth of Massachusetts<br>Executive Office of Environmental Affairs | 6 June 1977 |
| 21 | City of Westfield, Massachusetts<br>Office of the Mayor | 2 May 1977 |
| 22 | City of Westfield, Massachusetts<br>Planning Board | 23 June 1975 |
| 23 | Town of Agawam, Massachusetts<br>Conservation Commission | 1 Apr 1975 |
| 24 | Commonwealth of Massachusetts<br>Dept. of Public Works | Mar 1975 |
| 25 | City of Westfield, Massachusetts<br>Planning Board | 26 Mar 1975 |
| 26 | Town of West Springfield, Massachusetts<br>Conservation Commission | 24 Mar 1975 |
| 27 | Commonwealth of Massachusetts<br>Dept. of Public Works | 28 Feb 1975 |
| 28 | City of Westfield, Massachusetts<br>Office of the Mayor | 1 Apr 1974 |
| 29 | City of Westfield, Massachusetts<br>Office of the Mayor | 16 Sept 1969 |

United States Department of the Interior

OFFICE OF THE SECRETARY
Northeast Region
15 State Street
Boston, Massachusetts 02109

ER-78/1197

February 13, 1979

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

This is in response to your request for the Department of the Interior's comments on the draft Environmental Impact Statement and Survey Report on the Westfield River Local Protection Project, Westfield, Massachusetts. These comments are provided in accordance with the National Environmental Policy Act. The Fish and Wildlife Service has already sent you comments on the draft Survey Report in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), opposing this project.

General Comments

The draft EIS adequately addresses cultural and recreational resource considerations in the project vicinity.

The draft EIS does not adequately assess the environmental impact of the proposed project since it does not discuss the proposed action in relation to Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). The proposed action appears contrary to the intent of these orders as they relate to support of development in the floodplain; the restoration and preservation of natural and beneficial floodplain values; the incorporation of the framework of floodplain management; and the locating of structures in wetlands.

The New England River Basins Commission in the River's Reach recommended the preservation of seven key natural storage areas including the floodplain around Westfield. The environmental impacts of the loss of this natural storage area should be evaluated in the final statement.

It is indicated that a separate environmental statement will be prepared for the additional protection required in West Springfield to compensate for the higher flood stages that would be caused by the present project. In the final analysis, it appears that these two actions should be

AMERICAN REVOLUTION BICENTENNIAL

considered together. It is not clear whether the costs of the West Springfield action have been included in the estimate of costs; an item called "Downstream Mitigation" is included (Survey Report, p. 56) but there is no explanation as to whether this would cover the required work in West Springfield.

Non-structural alternatives are not adequately addressed.

Alternatives to reduce the amount of open and agricultural land that is protected should be developed.

The final EIS should at least discuss the occurrence and use of ground water in the project area and should assess the beneficial or adverse impacts on ground water in the area, where flooding would be increased.

Mineral commodities currently produced in Hampden County are stone, sand and gravel. According to the Bureau of Mines, three active sand and gravel pits and a stone quarry are located within 5 miles of the project area, though none would be directly affected by the proposed construction. There should be minimal effect on mineral resources. However, the Survey Report and the final EIS should be amended to reflect the current status of mineral activity in the area.

SPECIFIC COMMENTS - DEIS

Page 4-7: In the section on water quality impact it is stated that: "...this project would be designed to allow more than 3 cfs of water through the natural channel during the spring freshet; this should be more than sufficient to keep the channel clear of any debris." This statement is unclear as to how much more than 3 cfs would pass through the natural channel. It would have to be considerably more than 3 cfs to maintain water quality and a productive aquatic ecosystem. In a planning aid letter of December 2, 1977, the Fish and Wildlife Service recommended that all flows, less than twice the average discharge, be confined to natural river channels. According to our estimates, the average discharge at the Westfield River sill location would be approximately 680 cfs and at the Little River sill it would be 170 cfs.

Page 4-8, Less Than Significant Impact 3: We feel that the loss of natural terrestrial and aquatic habitat is significant especially in the immediate project area as opposed to your watershed comparison. The Westfield River is included in the Connecticut River Anadromous Fish Restoration Program. Therefore, the integrity of the natural stream channels must be maintained. The local impacts on fish and wildlife resources should be more adequately addressed in the final statement.

Page 4-10: Impact 6 is significant. In respect to Executive Order 11988, the development of floodplain land is more than a local concern. The discussion of this impact should be expanded in the final statement.

Page 7-1, Section 7.01: It should be indicated that the shift in types of species present could very likely be towards undesirable species such as starlings and house sparrows.

Page 7-1, Section 7.03: Again the relationship between increased flood-plain development and Executive Order 11988 should be indicated.

<u>SPECIFIC COMMENTS</u> - <u>DRAFT SURVEY REPORT</u>

Pages 13-14: The discussion of the mineral resources of the Westfield River Basin, which includes portions of Berkshire, Franklin, Hampden, and Hampshire Counties, is misleading and erroneous. This section states that "Various mineral deposits are to be found..., but few are of commercial value." Our records indicate that sand and gravel pits and stone quarries are active throughout the basin. The sentence, "At present, mining and quarrying activities in the basin include manganese mining at Plainfield, ..." is incorrect. A manganese deposit exists near Plainfield but is not currently mined. Also, our records indicate that clay, marble, and peat are not presently being mined at Westfield.

Thank you for the opportunity to comment.

Sincerely yours,

William Patterson

William Patterson
Regional Environmental Officer

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGION I
JOHN F. KENNEDY FEDERAL BUILDING
GOVERNMENT CENTER
BOSTON, MASSACHUSETTS 02203

OFFICE OF
REGIONAL DIRECTOR

February 9, 1979

Mr. Joseph L. Ignazio
Chief, Planning Division
Department of the Army
New England Division, Corps
of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Ignazio:

HEW's review of the EIS on Local Flood Protection, Westfield, Mass., shows no effect on shellfish growing areas since the project area is approximately 80 miles from Long Island Sound. However, this project will have an undesirable effect on the habitat of birds and fish in the project area. The downstream area will also show effects of lowered dissolved oxygen levels. In some areas, the flow regulation and reduced oxygen may combine to form septic conditions, with attendant loss of fish, animal, and bird life, and production of hydrogen sulfide gas.

The effects of the noise, dust, and traffic hazard to inhabitants along the truck routes should also be considered in more detail.

We note in the back of the report no agencies, schools or hospitals from Connecticut were included in the distribution. Since the project will have some downstream effects, it would probably be advisable to include all educational and health agencies in the impact area.

Should the status of this project be reversed and a flood control project implemented, the environmental effects should be reassessed.

Thank you for giving us the opportunity to review and comment on this project.

Sincerely yours,

Donald H Branum

Donald Branum
Regional Environmental Officer

cc: Charles Custard, Director, OEA, HEW, Washington
Ray Goldberg, ROFEC, Washington

Exhibit No. 2

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
AREA OFFICE
BULFINCH BUILDING, 15 NEW CHARDON STREET
BOSTON, MASSACHUSETTS 02114

REGION I
Room 800
John F. Kennedy Federal Building
Boston, Massachusetts 02203

IN REPLY REFER TO:

Mr. Joseph L. Ignazio, Chief
Planning Division
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Draft Environmental Impact Statement
Westfield River
Local Protection Project
Westfield, Massachusetts

Dear Mr. Ignazio:

The HUD Regional Office submitted the above Statement to the HUD Boston Area Office for review and comment.

In review of the above Draft EIS this office finds no conflict with HUD programs or objectives.

Thank you for giving this office the opportunity to review and comment on the DEIS.

Sincerely,

Area Manager

Exhibit No. 3

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
One Gateway Center, Suite 700
NEWTON CORNER, MASSACHUSETTS 02158

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

This Fish and Wildlife report constitutes our comments on the draft Survey Report for Local Flood Protection, Westfield, Massachusetts. It supplements and updates previous planning aid letters and is submitted in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

The concerns of this Service center on Executive Orders 11988 and 11990 (Floodplain Management and Protection of Wetlands), the loss of natural flood storage and the effects downstream, the maintenance of the integrity of the existing natural river channels, conditions for fish passage through conduits, and the loss of terrestrial wildlife habitat.

The proposed action appears contrary to Executive Order 11988 on floodplain management as it relates to support of development in the floodplain; the restoration and preservation of natural and beneficial floodplain values; and the incorporation of the framework of floodplain management. The development of existing agricultural and fallow floodplain land for residential, commercial or industrial uses made possible by this flood protection project would negatively impact wildlife resources and prevent their enhancement. The locating of the Powdermill Brook dike and the Westfield and Little River overflow channels through wetlands will result in the destruction of these wetlands. These wetlands are small but provide significant habitat for the fish and wildlife resources of the area. A change in alignment of the dikes (or the use of floodwalls if necessary) and overflow channels resulting in the wetland areas being on the riverside of these protective structures would aid in the preservation of these natural resources.

As stated in the Survey report, the implementation of the selected plan would result in the loss of a significant amount of natural flood storage. This natural flood storage area has been recognized by the New England River Basins Commission in the River's Reach as one of seven key natural

flood storage areas in the Connecticut River Basin and recommends its preservation. The loss of this natural flood storage area will necessitate modification of the local protection works in West Springfield, Massachusetts. The effects that this modification will have on the fish and wildlife resources of the West Springfield area could be significant and must be addressed in conjunction with the Westfield project. Realizing the need for flood control in Westfield, we feel that the alignment of the protective works should be designed to minimize the amount of open space (natural flood storage area) that is protected.

The integrity of the natural stream channels must be maintained. The Westfield River has been designated for restoration of Atlantic salmon runs in the Connecticut River Anadromous Fish Restoration Program. Some Atlantic salmon may be trucked to suitable spawning and nursery habitat in the upper basin in the near future. The sea-run smolts will, therefore, pass through Westfield on their travels downstream. A limited American shad fishery may also be developed in the lower portion of the main stem. We are also concerned with local fish movement and the maintenance and improvement of water quality. Therefore, all new channels should be designed as overflow channels. As stated in planning aid letters of August 15, 1977, and December 2, 1977, all flows, less than twice the average discharge, should be confined to natural river channels. To accomplish this, a concrete sill should be constructed in the proposed overflow channels for the Westfield and Little Rivers. According to our estimates, the average discharge at the Westfield sill location should be approximately 680 cfs and at the Little River sill it would be 170 cfs. These recommendations were not followed in the Survey report, the DEIS, and the Hydrologic Analysis for Flood Control in Westfield, Massachusetts (May 1978). The other channel relocations on the Little River and Powdermill Brook should be designed as overflow channels with the same discharge parameters as stated above. As designed in the selected plan, the Westfield River overflow channel would permanently cut off a meander downstream of the sewage treatment plant. This overflow channel should be redesigned to maintain this meander as part of the Westfield River.

We recommend that the Westfield River dike follow the alignment of the existing dike. The Little River dike should be placed as far back from the river as possible, generally on the northwest side of South Meadow Road, eliminating the protection of open and agricultural land. These two dikes would join at the confluence of the Westfield and Little Rivers eliminating the need for gated conduits. The overflow channels and non-structural measures would provide protection downstream. The pressure conduit on Powdermill Brook may prove to be an effective barrier to fish movement. Since Powdermill Brook has a naturally reproducing trout population, we recommend that the pressure conduit be replaced with flood walls and a street gate.

The selected plan will have a negative impact on the wildlife resources of the area. The proposed alignment of the dikes will destroy a significant amount of riparian vegetation that is important wildlife habitat and is a decreasing natural resource. Implementation of the selected plan may

also result in the loss of riparian vegetation downstream in West Springfield due to the modification of local protection structures. Also, the protection of agricultural and fallow land would result in the loss of present wildlife habitat and enhancement possibilities through the development that would follow protection. In our planning aid letter of August 15, 1977, we recommended that riprap be used on the dikes only where it is needed, and that the other dikes be planted with shrubs, vines, herbs, and grasses. However, in the Hydrology report (May 1978) it is stated that all dikes and the banks of relocated river sections would be protected with riprap even though the tractive forces on streambanks and dikes in the Westfield area are generally low due to the hydraulic character of the floodplain and flat stream gradients. This action would further degrade the wildlife resources. We reiterate our previous recommendation.

We recommend against authorization of this project as it is presently planned. However, we recognize the need for flood protection for the central core of the City of Westfield and limited areas along Union Street. Therefore, the placement of the dikes should be as far back from the rivers as possible and eliminate the protection of undeveloped floodplain areas. Non-structural alternatives should be considered for the primarily commercial development downstream of the confluence of the Westfield and Little Rivers along U.S. Route 20 and all other undeveloped or sparsely developed areas in the city.

Sincerely yours,

Howard N. Larsen

Regional Director

*The Commonwealth of Massachusetts*

*Office of the Secretary*

*Massachusetts Historical Commission*

PAUL GUZZI

*Secretary of the Commonwealth*

*294 Washington Street Boston, Massachusetts 02108*

*(617) 727-8470*

November 22, 1978

Joseph L. Ignazio
Chief, Planning Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

RE: Westfield Local Flood Protection

Dear Mr. Ignazio:

Please excuse the delay of the response.

The Massachusetts Historical Commission has reviewed the "Phase 1/B Archaeological Properties Survey" for the Westfield Local Flood Protection Project. The report is clear and concise and should provide a good base on which to make management decisions in regards to significant cultural resources.

If the proposed project goes to a more advanced stage of planning, further review in compliance with section 106 of the National Historic Preservation Act of 1966 will be required. Since a number of historic resources have been identified, the Corps will need to consult with the Massachusetts Historical Commission in order to determine which properties in the impact area appear to meet the criteria of eligibility to the National Register (36 CFR 800.4(2)). Although much site specific information is available in the report, very little contextual information discussing the social and historical relationships of properties is included. It is difficult to place the properties in a research framework, and thus evaluate significance.

The Massachusetts Historical Commission suggests that the Corps arrange a meeting among the consulting archaeologists and Valerie Talmage, Staff Archaeologist, in order to discuss (1) the potential significance of the properties, (2) the informatio necessary for requesting a Determination of Eligibility from the Secretary of the Interior, (3) the scope of work necessary for acquiring additional information, and (4) the scheduling of the 106 review. Please feel free to contact the Massachuset Historical Commission for such a meeting when convenient in the project schedule.

If you have any questions, call Valerie Talmage, Staff Archaeologist.

Sincerely,

Patricia L. Weslowski

Patricia L. Weslowski
State Historic Preservation Officer
Executive Director

Exhibit No. 5

United States Department of the Interior
HERITAGE CONSERVATION AND RECREATION SERVICE
INTERAGENCY ARCHEOLOGICAL SERVICES-ATLANTA
1895 Phoenix Boulevard
Atlanta, Georgia 30349

IN REPLY REFER TO:

H2217-IAS-A

OCT 1978

Mr. Joseph L. Ignazio
Chief, Planning Division
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Ignazio:

Enclosed are copies of this offices reviews of the report entitled "Phase IB/Archaeological Properties Survey for Unreported Sites, Westfield Local Flood Protection Project" by Mitchell Mulholland and Kenneth Quilty.

Both reviewers expressed concern with the justification for the recommendations and budget.

We appreciate the opportunity to review this report.

Sincerely,

Bennie C. Keel

Bennie C. Keel
Chief

Enclosure

Exhibit No. 6

*The Commonwealth of Massachusetts*
*Department of Environmental Quality Engineering*
**WESTERN DISTRICT**
WESTERN MASSACHUSETTS PUBLIC HEALTH CENTER
UNIVERSITY OF MASSACHUSETTS, AMHERST 01002

(413) 549-1917
(413) 545-2610

April 4, 1978

Joseph E. Rodgers
Westfield Associates
75 Broad Street
Westfield, MA 01085

RE: DEQE File No. 333-41, Westfield

Dear Mr. Rodgers:

Acting under the provisions of the Wetlands Protection Act (Chapter 131, section 40 of the General Laws), the Department of Environmental Quality Engineering has reviewed your Notice of Intent and plans filed under DEQE File No. 333-41, relative to the proposed construction of a commercial shopping mall at East Main Street in the City of Westfield.

The Department has determined that the area of the proposed activity is significant to the interests of the Act, specifically to the interests of flood control, storm damage prevention, and the prevention of pollution.

In order to protect the interests of the Act, and for the reasons set forth below, the Department denies the permit requested for the proposed project. The Superseding Order issued in this case is enclosed.

An on-site inspection, of which all parties were notified, was conducted by the Department on March 9, 1978. The Department requested further information concerning the project from the applicant on February 27, 1978. Additional information was received from the applicant's engineering consultant, and additional information and comments were also received from various interested agencies and groups.

Information concerning flood hazard conditions in Westfield and in the project area was reviewed. Studies and reports consulted included: Flood Plain Information Report, Westfield, U.S. Army Corps of Engineers (1969); The River's Reach: A Unified Program for Flood Plain Management in the Connecticut River Basin, New England River Basins Commission (1976); Flood Insurance Study, City of Westfield, Camp, Dresser & McKee for the Federal Flood Insurance Administration (1977). The Department considers the information contained in the 1977 Flood Insurance study to be the best available engineering data relative to flood levels, floodway locations, and flood hazards in the project area.

The severity and frequency of flooding and flood damages in the City of Westfield have been well documented in the reports mentioned above. The New England River Basins Commission's report finds that "the worst potential for loss of lives and property damage outside the seven lower main stem diked cities probably exists in Westfield, Massachusetts", and that "All things considered — flood history, flash flood potential, potential for loss of life, existing property damage potential, potential for increasing damages, and the need for action on several fronts — Westfield has no match in the Connecticut River Basin."

Studies indicate that the Westfield River in Westfield reaches flood stages very rapidly, with rates of rise in excess of two feet per hour, and that the duration of flooding may be as long as two days. Velocity flows during the 100 year flood (also defined as the intermediate regional flood, and is the flood event which has a 1% probability of occurring in any given year) may range up to 6 feet per second in overbank areas.

The site of the proposed project is a 24.3 acre parcel on the south bank of the Westfield River, just upstream of the East Main Street bridge, approximately 1.0 stream miles downstream from the confluence of the Westfield and Little Rivers, and approximately 2.0 stream miles upstream of the U.S.G.S. Gaging Station No. 01183500. In the 50 year period from 1927 to 1977, four floods have exceeded the discharge of the 50 year flood at the project site. One of these floods exceeded the 100 year discharge. The site is presently at an average elevation of approximately 122 feet mean sea level (msl), and is entirely within the floodplain of the intermediate regional flood. The elevation of the intermediate regional flood at the site is at 132 feet msl, resulting in depths of 10 feet of floodwater. The site is also entirely within the 50 year floodplain, which reaches an elevation of 127.5 feet msl, resulting in 5.5 feet of floodwater on the site.

The Department finds that the proposed buildings for this project are located entirely within the Westfield River floodway which has been engineered and delineated for the Federal Flood Insurance Study, and which is the area including and adjacent to the river channel which must be kept free from encroachment in order to pass the discharge of the 100 year flood without substantial increases in flood height.

The wide floodplain area below the confluence of the Westfield and Little Rivers has been identified by the New England River Basins Commission report and the Flood Insurance Study as an important and significant natural valley flood storage area which modifies and reduces peak flood flows downstream.

The Department finds and determines, therefore, that the site of the proposed activity is clearly significant to the interests of flood control and storm damage prevention.

The proposed project involves construction of a retail shopping mall on the site described above, and includes 136,000 square feet of structures, parking areas for approximately 800 vehicles, and associated site filling, grading and drainage.

e Department is of the opinion that in this case there are three basic minimum uirements which are essential to protect the interests of flood control and storm damage prevention. First, any structures must be floodproofed up to the level of the intermediate regional, or 100 year, flood so as to be water-tight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy. Second, there must be no encroachment by fill or structures on the Westfield River floodway, as shown on the Flood Boundary and Floodway Map which is part of the 1977 Flood Insurance Study, and which is also shown on the project site plan submitted to this office. Third, any flood storage below the level of the 100 year flood displaced by fill and structures must be compensated for by the provision of equivalent flood storage capacity at the project site.

The Department finds that the proposed structures include no provision for floodproofing. The Department further finds that properly floodproofed structures and associated filling at the site would result in displacement of more than one and one half million cubic feet, which represents a substantial floodway encroachment and loss of flood storage.

It is apparent that the project as proposed does not meet any of the above requirements, and therefore must be denied. This denial does not preclude alternative designs or uses of the site which meet the requirements set forth above and in the enclosed Superseding Order. Any such redesign, however, would require a new filing under General Laws Chapter 131, section 40.

ır attention is directed to the appeal provisions included in the enclosed Superseding Order.

Very truly yours,
For the Commissioner,

Angelo Iantosca

Angelo Iantosca
Regional Environmental Engineer

AI:AW:cap

CC: Westfield Conservation Commission
Westfield Flood Control Commission
Gary Beluzo, et. al. (appellants)
Westfield City Council
Mayor Garreth Lynch
West Springfield Conservation Commission
Agawam Conservation Commission
Lower Pioneer Valley Regional Planning Commission
U.S. Army Corps of Engineers
Hampden County Division, M.A.C.C.
Hampden Conservation District
Westfield River Watershed Association

THE COMMONWEALTH OF MASSACHUSETTS

ORDER

WETLANDS PROTECTION ACT

G.L. Ch. 131, s. 40

File No. 333-41

Project Location: East Main Street, Westfield River, Westfield

TO: Joseph E. Rodgers
Westfield Associates
75 Broad Street
Westfield, Mass. 01085

RE: Notice of Intent dated: 12/22/77

Pursuant to the authority of General Laws Chapter 131, section 40, the Department of Environmental Quality Engineering has considered your Notice of Intent, plans and other information submitted, and has determined that the area on which the proposed work is to be done is significant to one or more of the interests described in the said act.

This application for a permit to alter land subject to the jurisdiction of the Act is hereby denied, on the grounds that structures are not properly floodproofed, that the project encroaches on the Westfield River floodway, and that the project does not provide for compensatory flood storage. Any resubmission of a new filing for this area must be made to the Westfield Conservation Commission and must be in accordance with the following minimum requirements and guidelines:

1. The activity shall not involve the placing of fill or structures within the Westfield River floodway as designated by Flood Insurance Study for the City of Westfield.

2. Any commercial structure located on site but not within the designated floodway shall be floodproofed up to the elevation of 132 feet mean sea level.

3. Any displacement by filling or structures on site shall be accompanied by the provision of compensatory flood storage capacity.

4. The provisions of Massachusetts Environmental Policy Act (Chapter 30, sections 62 to 62H of the General Laws) must be met.

The applicant, any person aggrieved by this order, any owner of land a ting the land upon which the proposed work is to be done, or any ten residents of the city or town in which such land is located, are hereby notified of their right to appeal this order to the Department of Environmental Quality Engineering, provided the request is made in writing and by certified mail to the Department of Environmental Quality Engineering within ten (10) days from the issuance of this order.

Where the Department of Environmental Quality Engineering issues a Superseding Order, you are hereby notified of your right to a formal hearing pursuant to the provisions of G.L. Chapter 30A, section 10. The request for a hearing must be made in writing to the Department of Environmental Quality Engineering within ten (10) days following the issuance of the Superseding Order.

---

ISSUED BY Angelo Iantosca

Angelo Iantosca

~~Regional Environmental Engineer~~

Dept. of Environmental Quality Eng.

Western Mass. Public Health Center

U. Mass, Amherst, MA 01003

April 4, 1978

DATE OF ISSUANCE

On this 4th day of April 19, before me personally appeared Angelo Iantosca to me known to be the person described in and who executed the foregoing instrument and acknowledged that he executed the same as his free act and deed.

Donna C. La Croix My commission expires: 29 December 1983

# United States Department of the Interior

HERITAGE CONSERVATION AND RECREATION SERVICE
INTERAGENCY ARCHEOLOGICAL SERVICES-ATLANTA
1895 Phoenix Boulevard
Atlanta, Georgia 30349

IN REPLY REFER TO:
H2217-IAS-A

Mr. Joseph L. Ignazio
Chief, Planning Division
New England Division, Corps
of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Ignazio:

We received the report entitled "Phase IB/Archaeological Properties Survey for Unreported Sites Westfield Local Flood Protections Project" by Mitchell Mulholland and Kenneth Quilty.

We shall review the report and provide our comments by September 18, 1978.

Sincerely yours,

for Bennie C. Keel
Chief

Exhibit No. 8

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Ecological Services
P. O. Box 1518
Concord, New Hampshire 03301

December 2, 1977

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

This letter is a supplement to our Planning Aid Letter of August 15, 1977, on the proposed Westfield Local Protection Project, Massachusetts. The material has been assembled with the assistance of a Service Hydrological Engineer.

The Westfield River system is not anticipated to play a significant role in the Connecticut River Anadromous Fish Restoration Program because of the large number of existing (13) and proposed (11) dams and impoundments. However, some Atlantic salmon may be trucked to suitable spawning and nursery habitat in the upper basin sometime in the future. The sea-run smolts will, therefore, pass through Westfield on their travels downstream. In addition, a limited American shad fishery may be developed in the lower portion of the main stem.

We reiterate our planning recommendation that all flows, less than twice the average discharge, be confined to natural river channels. A concrete sill should be constructed in the proposed overflow channels in the Westfield and Little Rivers to accomplish this. According to our estimates, the average discharge at the Westfield sill location would be approximately 680 cfs and at the Little River sill it would be 170 cfs.

To provide adequate flow conditions for fish passage, we recommend that the three gated conduits proposed for the Westfield River and the two gated conduits proposed for the Little River be designed to pass twice the average flow with a minimum of two feet of freeboard between the water surface and the crown of the conduit. Also, a "zone of passage" should be created in the conduits. This "zone" should have a width of 4-6 feet and an average velocity of 4 fps or less, for flows up to twice the average discharge. Flow deflectors or baffles may be required for this purpose.

Assuming that the overflow channels will only be used for flows over twice the average discharge, fish passage facilities should not be needed.

We hope these comments will assist you in your planning efforts.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor

# The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

MICHAEL S. DUKAKIS
GOVERNOR

EVELYN F. MURPHY
SECRETARY

September 20, 1977

Joseph L. Ignazio, Chief
Planning Division
New England, Corps of
Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Ignazio:

My staff has reviewed the material you sent this office concerning the Westfield Local Protection Project. Their concern focussed on three issues:

1. The impact of the project on downstream communities, especially West Springfield.

2. The necessity for protecting the land within the bend of the Little River which appears, from examination of the USGS topographic map, to be relatively undeveloped.

3. Follow-through on the part of Westfield to ensure that there will be no further development on what is left of the flood plain.

Discussions with Mr. McCarthy of the Environmental Section have indicated that these concerns, as well as others, will be addressed in the EIS.

I appreciate your involving this office in the preliminary stages of your work on the EIS, and hope this cooperation is continued. We look forward to receiving what will apparently be a comprehensive Draft EIS on this project.

Sincerely yours,

William F. M. Hicks

William F. M. Hicks

Exhibit No. 10

WFMH/arm

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Concord Field Office
55 Pleasant Street
P. O. Box 1518
Concord, New Hampshire 03301

August 15, 1977

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

Pursuant to Joseph L. Ignazio's letter of May 26, 1977, the following is the U.S. Fish and Wildlife Service's Planning Aid Letter on the proposed Westfield Local Protection Project, Westfield, Massachusetts. This letter is intended to aid in your planning and design of the most environmentally sound project as possible. It should not be construed as the official report or the position of the U.S. Fish and Wildlife Service.

The proposed project is intended to control floodwaters from the Westfield River, Little River, and Powdermill Brook and prevent flood damages to the majority of the City of Westfield.

The current concerns of the Service can be broken into units based on the various facets of proposed construction, as shown on your "Westfield Local Protection General Plan dated March 1977", and are discussed as follows:

(1) Dike and wall system
(2) Overflow systems and channel relocations
(3) General clearing and bank stabilization
(4) Interior drainage
(5) Effects upstream and downstream

(1) The dike and wall system involves approximately 43,000 feet of earthen dikes and 5,000 feet of concrete wall along the south side of Powdermill Brook, the north and south sides of the Westfield River and the north side of the Little River. In general, the Service would prefer that the dikes be moved back from the river enough to allow the riverbank vegetation to remain. The trees provide shade to the river and help keep the temperature down. There is also some concern for the north bank of Powdermill Brook. We believe that the sandy cliff which is currently eroding will erode at a considerably faster rate when flood waters are confined between it and the proposed dike. This potential problem of accelerated erosion should receive further investigation.

We understand that the dikes will be planted to grass except for areas which necessitate a rock face. This will significantly alter existing terrestrial habitat resulting in a reduced diversity of habitat and wildlife populations. We believe that diversity can be maintained without destroying the integrity of the dikes through selective planting of shrubs vines, herbs, and grasses. Such plantings would provide food and/or cover for birds, small mammals, and reptiles and would provide a more diversified greenbelt for an urban area such as Westfield. A partial list of plant species which may be appropriate include:

smooth and staghorn sumac (*Rhus glabra* and *R. Typhina*)
raspberries (*Rubus* spp.)
multiflora rose (*Rosa multiflora*)
autumn olive (*Eleagnus umbellata*)
barberry (*Berberis canadensis*)
dogwood (*Cornus* spp.)
juniper (*Juniperus communis* or *J. horizontalis*)
goldenrod (*Solidago* spp.)
milkweed (*Asclepias* spp.)
grape (*Vitis novae-angliae*)
honeysuckle (*Lonicera* spp.)
Virginia creeper (*Parthenocissus quinquefolia* L.)

Along the water's edge certain wetland species would be appropriate to hold the bank, improve the aesthetics, and to provide some shelter for fish, birds, and other riverine organisms. Some possibilities include:

Hazel alder (*Alnus serrulata* (Ait.) Wild.)
Red-osier dogwood (*Cornus stolonifera* michx.)
American hornbeam (*Carpinus caroliniana* Walt.)
Swamp rose (*Rosa palustria* Marsh)
Nannyberry (*Viburnum lentago* L.)
Pussy willow (*Salix discolor* Muhl)
Alternate-leaf dogwood (*Cornus alternifolia* L.)

Whenever possible, fisherman access should be provided. Due to the urban setting, there probably will be little occasion to have hunting in these areas but general, non-consumptive wildlife uses should be planned, i.e. trails, special plantings, parking facilities, etc.

The General Plan does not indicate the source of material for construction of the earthen dikes. It appears that an enormous volume of material will be required which will result in an extensive borrow area (s). We would appreciate the opportunity to comment on the environmental impact of such borrow areas.

(2) Two overflow channels are currently proposed. One would cut through the large meander in the Westfield which goes around the sewage treatment plant and the small reverse meander immediately downstream. Current plans would allow for gated conduits to permit water to pass through the natural channel of the large meander but the small meander would be permanently cut off and allowed to dry out or fill in with vegetation. The other channel

could cut across from the sharp northerly turn of the Little River to the Westfield. A gated conduit at the turn of the river would allow water to continue to flow through the natural streambed except during serious floods. These channels would be used to drain off excess water during heavy rainfall--perhaps 10-15 times/year. Apparently the primary reason for such frequent use, resulting from a low sill, is to remind people that it is not a depository for trash. Unfortunately, people will dump into areas of existing water--as evidenced by the wetland areas where the Little River overflow channel is proposed. The Service strongly suggests that the sills be as high as possible without causing any flooding of residences, to insure periodic flushing and cooling of the natural stream channel. The minimum sill height should be high enough to provide about 200% over the average annual flow in this channel and a minimum of 3 fps at high flows. Particularly in the summer when the water temperature begins to rise, any rains are valuable to lower the water temperature. Also, some species of fish, including the anadromous Atlantic salmon, require cobble and rubble areas for their redds, or spawning sites. Continual low and/or slow flows will result in siltation of these areas and loss of such sections as potential spawning grounds. This is of growing interest as the water quality of these rivers improves.

The final sill height will determine the Service's concern with the "interior" of the floodway. If it is to be flooded annually or more often, it should be designed for fish passage. This might involve artificial riffles or a series of curbs. If it will be flooded less than annually, it should be designed against fish passage. That is, fish would be discouraged from entering the overflow channel at either end. The Service will provide assistance in this design work once the particulars and the sill height are determined or when requested.

The gated conduits through the dikes involve both the dikes and overflow channels. There is concern that three 4' X 4' conduits on each end of the large bend in the Westfield and two 4' X 4' conduits on the Little River will result in velocities through the conduits which are considerably greater than are found upstream or downstream. This could seriously hamper fish passage along the river and might result in siltation on the upstream and/or downstream sides of the conduits. The result would be a significant change in the character of the rivers in the City. Additional data on the hydrology of the plan is needed.

The small meander in the Westfield to be cut off entirely is also a problem. There is significant wetland and riverine habitat in that area which should be preserved. The engineering aspects of construction in this area need clarification and, perhaps, modification. The Service offers its assistance in the development of possible alternatives in order to minimize adverse impacts on existing resources.

The Powdermill Brook channel relocation of about 1,500 feet, easterly of the Route 10 and 202 bridge, is a concern but with proper mitigation would be generally acceptable. It does not appear that the easternmost 600 or so feet needs to be relocated. If any channel relocation is deemed necessary, it

should be limited to the straightening of the right angle turn area which appears to be an unnatural course itself. The northern bank of the relocated area should be revegetated with shrubs and trees to replace those to be lost on the south side.

(3) General clearing and bank stabilization is another facet of the project. The Service generally opposes clearing that is not essential to the prevention of floods or severe erosion. Bank stabilization by rock is recognized to be necessary in areas of high velocity but the use of rock should be minimized in low velocity areas. Planting shrubs or trees for bank stabilization is preferred since it can afford wildlife a source of food and cover.

(4) Interior drainage does not appear to be a problem. There are two ponding areas planned: one north of Shepard Street along the Westfield River dike and the other called the South Meadow Road Ponding Area which is east of South Meadow Road. Pumping stations are planned for the easterly corner of the Powdermill Brook/Westfield River dike system and the downstream end of the large Westfield meander. The natural river channels are the low areas in the city. They will collect most of the runoff and are expected to be 10-20 times as full as during a normal summer season. Although the sewage treatment plant will continue to empty into the river inside the dikes, there will be a large pump to keep the water flowing out of the downstream portion into the overflow channel. If the flood continues beyond the dikes but the interior area is drained and the natural channel begins to empty, the gated conduits on the upstream end of the Little and Westfield Rivers will be cracked to maintain an adequate flow.

In both areas there will be increased non-point pollution from oil, grease, and other urban pollutants. This would occur whether or not the project was done and will be considerably reduced with the project. The chemical plant on Union Street and any other plant with potentially harmful material, should be encouraged to take measures to prevent problems from runoff from its piled materials. This could be accomplished with some sort of mini-dikes.

(5) Since the project will result in a faster flow of the three streams, the upstream effects must be considered. The faster the flow the faster the erosion and the greater the possibility that the river may find a shortcut and become straight. Loss of meanders indicate loss of habitat for fish and wildlife. Vegetation is destroyed, fish which need pools and calm waters lose them, and damage may be done to existing structures.

Effects downstream on West Springfield must also be considered, such as the need for additional dikes in that area and the possibility of increased erosion downstream.

Much of the above material is based on incomplete or out-of-date information. The Corps' hydrological report is as yet incomplete, as is the State's stream survey for the Westfield River Basin, and the State Division of Water Pollution Control's water quality report is being revised. The Service requests the opportunity to review these documents and other data and supplement and/or revise this planning aid letter.

Sincerely yours,

Gordon E. Beckett
Field Supervisor, CFO

*The Commonwealth of Massachusetts*
**Connecticut Valley Wildlife District**
*Division of Fisheries and Game*
~~Field Headquarters, Westboro 01581~~
East Street, Belchertown, Mass. 01007

June 29, 1977

Mr. Tom Ready
Dept. of the Army
New England Division Corp. of Engineers
424 Trapelo Road
Waltham, Mass. 02154

Dear Tom:

Thank you for the copy of the Westfield River plan. As for comments, I think Ruth Ladd will have most of them in her report. I will stay clear of the obvious problems where I feel law suits will follow since its none of my concern.

My main interest is in leaving all vegetation inside the dikes and plant the outside banks of the dikes to grass and herbaceous cover. Shrubs of any kind will do, but native kinds like sumac, grapevine, blackberry, green briar, crab apple and autumn olive planted in sections is most desirable. The cover left inside the dike to the river adds to provide shade, which helps maintain water temperatures in trout range and provide hunting cover which also adds another demention to recreational use of the area. Once the river is cleaned up a little more, shade is most important for maintaining cool temperatures needed to sustain trout and possibly salmon in the future.

I would also like to see the back water areas outside the dikes left open on the down stream end, to allow fish and water levels to come and go. Areas like these provide good bass and pickerel areas. Water flow, in and out will help keep the area from being a stagnant pool.

I can see future stocking and recreational use in both sections of the lower Westfield and little rivers. The Powdermill Brook area has little value as a fishery and relocating in that area doesn't bother me. I covered most of this verbally at our last on site meeting.

Feel free to call anytime if I can be of any assistance.

Sincerely yours

Herm Covey

Exhibit No. 12

Herm Covey
Wildlife District Manager

HC/ak

**WESTFIELD RIVER WATERSHED ASSOCIATION, INC.**

[redacted]

P. O. Box 256 Westfield, Mass. 01085 Telephone 562-3657

June 27, 1977

Mr. Joseph L. Ignazio
Corps of Engineers
424 Trapelo Road
Waltham, Mass. 02154

Westfield Local
<u>Protection Project</u>

Attention: Mr. Donald W. Martin

Dear Mr. Martin:

This is in response to your letter of May 26th to Mr. Carl Walker.

The Westfield River Watershed Association is concerned primarily with the impact of actions taken in a community on its upstream and downstream neighbors. We are not commenting on the merits of the proposed Westfield Local Protection Project as it affects Westfield itself.

As we have said in previous correspondence to you, we see no effect of the dyke plan upstream, but we are concerned about the downstream impact, primarily in the Town of West Springfield. We note that present studies being conducted in West Sprinfield include raising the West Springfield dyke system along the Westfield (Agawam) rivers to compensate for the effect of the Westfield system.

These two plans should be considered as one.

On another task, the Association is currently developing and coordinating plans for a "Greenbelt" along the Westfield River. Among many things, it may include canoe access facilities along the river. We believe that one or more of these facilities should be located in Westfield. At the time detail designs are made, we would like to work with you and the Westfield City Planner on such facilities.

Very truly yours,

Benjamin L. Bragg

Benjamin L. Bragg, III
Director & Consultant

Exhibit No. 13

BLB/sz

cc: Selectmen, West Springfield

*The Commonwealth of Massachusetts*
*Executive Office of Environmental Affairs*
*100 Cambridge Street*
*Boston, Massachusetts 02202*

MICHAEL S DUKAKIS
GOVERNOR

EVELYN F MURPHY
SECRETARY

June 24, 1977

Mr. Joseph L. Ignazio
Chief, Planning Division
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Ignazio:

Thank you for sending this office an outline of the Westfield Local Protection Project for review.

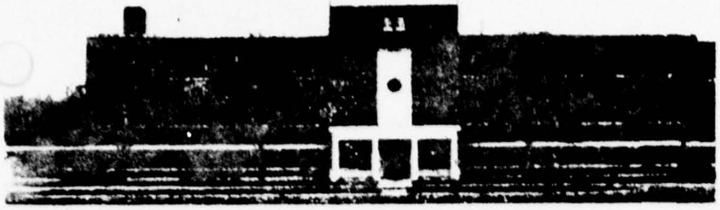
My staff has reviewed the material, but would like to wait until after the planned Briefing by the Corps on all the Westfield River projects before formally submitting comments.

Yours truly,

Evelyn F. Murphy, Secretary

EFM/LF/jmdi

Exhibit No. 14



Town of
WEST SPRINGFIELD
MASSACHUSETTS

OFFICE OF
BOARD OF SELECTMEN

CHARLES T. GRUCCI, CHAIRMAN
J. EDWARD CHRISTIAN, VICE CHAIRMAN
DR. FREDERICK S. CONLIN, JR., SECRETARY

June 24, 1977

Mr. Joseph L. Ignazio
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Re: Westfield Local Protection Project

Dear Mr. Ignazio:

We have followed the various studies on the two rivers which affect West Springfield, and have, from time to time, submitted our views to y and to other agencies. Included have been observations regarding the proposed Westfield Local Protection Project, and we have just become aware that you are requesting imput for a Draft Environmental Impact Statement for that project.

In accord with the general stand taken in our letter of Nov. 10,1976 to the New England River Basins Commission and included in The River's Reach, as well as letters of some of our other town officials to Colonel Mason and to the NERBC, we wish to point out the following:

1. If this project is carried out, the combined effect of the channelizing and the loss of flood storage will lead to a rise in the flood stage downstream and in West Springfield, by as much as 1½ feet according to an estimate presented by your own engineer at a NERBC hearing in West Springfield early last year.

2. This higher flood stage will additionally imperil areas in both Westfield and West Springfield, including:
   a. large areas of agricultural land in intensive use,
   b. A major state highway,
   c. a number of mills constituting the largest concentrated industrial grouping in West Springfield, as well as

26 Central Street
West Springfield, Mass. 01089

(continued)

d. extensive reaches of less developed flood plain acreage and riverfront in Westfield, West Springfield and Agawam.

3. The increased flow velocity will inevitably cause added erosion in the Agawam, - West Springfield reaches from Mile 8 to Mile 2.4, and this erosion plus loss of the natural deposition areas upstream will in turn increase the sedimentation (and additionally raise the flood stage) in the reach below Mile 2.4.

4. That part of the proposal which relates to raising the existing dike system in West Springfield from Mile 3.1 to Mile 0 at the confluence with the Connecticut River (and which was not mentioned in the Project Description) to compensate for the higher flood stage would have certain undesirable aspects:

a. certain portions of the dike, Mile 2.3 to Mile 3.1, are in a location with severe limitations for the acquisition of additional easement width.
b. the Town has developed considerably since the original dike construction, and borrow sites are no longer locally available, and
c. trucking would be on routes which have not become heavily traveled, and would cause serious congestion.

We ask that due note be taken of the foregoing in preparing your Draft EIS. We also feel that we should ask to have recorded our opposition to the project as a whole, at least until such time as satisfactory answers are obtained to the points we have raised.

Very truly yours,

BOARD OF SELECTMEN

Charles T. Grucci

CHARLES T. GRUCCI, Chairman

J. Edward Christian

J. EDWARD CHRISTIAN, Vice Chrmn.

Frederick S. Conlin Jr.

FREDERICK S. CONLIN, JR., Secretary

Exhibit No. 15
Page 2

RV/evm
cc: Mayor Rhodes

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
29 Cottage Street, P.O. Box 848, Amherst, Massachusetts 01002

June 24, 1977

Mr. Joseph L. Ignazio
Chief, Planning Division
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Attention of: NEDPL-R

Dear Mr. Ignazio:

We appreciated the opportunity to review the material detailing the proposed Westfield Local Protection Project. Our comments regarding possible significant environmental impacts are as follows:

1. Positive flood protection by diking of prime farmlands in the flood plains will probably result in their conversion to urban uses. This will occur significantly between Little River and South Meadow Road; east of the existing state dike and west of the new Westfield River channel; and in the Roselli Brothers' farm area northeast of Notre Dame Street.

2. There will be a loss of flood storage capacity caused by diking out large areas of flood plain.

3. Because of item 2 and also to a limited degree the straightening of the Little River channel, higher stages of flood flows at higher velocities will be produced downstream.

4. Higher stages downstream will produce greater flooding of prime farmland in the bend east of Frog Hole and between Little River Road and the Westfield River. Although not important agriculturally, the area between Powdermill and the Westfield below the north dike will also receive greater flooding.

5. Higher velocities downstream can be expected to produce increased riverbank erosion. Such erosion is already severe on bends below the project area.

6. Higher velocities through the project area will result in greater bed load movement with deposition downstream and greater impetus to meandering downstream.

7. Backwater effects of higher stages through Westfield can be expected especially for such nearby low lying areas as the Tekoa Country Club plain and the extensive prime agricultural lands northeast and across the river from the Tekoa Country Club.

8. On Little River, diking of the north side only and the generally higher stages discussed above will produce greater and more frequent flooding of prime agricultural farmland on the south side of Little River east of Route 202 (Hundred Acre Brook Area).

9. The project description seems to state that the old Little River and Westfield River channels will normally be "dry". Maintenance of these flood channels will be a problem; they will also probably contain seasonal shallow pools and serve as storm runoff channels.

Sincerely,

Philip Christensen, acting

Dr. Benjamin Isgur
State Conservationist

cc: Mr. William Warren
District Conservationist
SCS, Hadley, Mass.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I

J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203

June 21, 1977

Mr. Joseph L. Ignazio
Chief, Planning Division
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

Dear Mr. Ignazio:

I have reviewed the information you forwarded on May 26, 1977 regarding the proposed Westfield Local Protection project. Although the information was very preliminary and lacked some detail, I did use EPA's guidelines for review of channelization projects in evaluating the project and am forwarding the following list of comments and concerns.

1. The Westfield River overflow channel has the potential for greatly increased velocities and may cause erosion and other damage at its discharge point or the bend in the natural river bed downstream. Increased velocities would cause excessive scouring of the natural stream bed and even worse disruption than natural flood conditions.

2. A thorough discussion of the operating and maintenance characteristics should be included in the draft. The overflow channels and conduits have a potential for becoming insect and pest sources as well as eye sores. What mitigating measures will be taken and who will be responsible.

3. A thorough discussion and projection of increased downstream flooding due to the project should be included in the draft.

4. Are any of the ponding areas, which would be changed due to the dikes, characterized as wet lands?

5. The draft should present much more information on existing conditions, the proposed project and expected impacts.

6. I suggest that a close study on structural and non-structural (operating and maintenance) mitigating measures for some impacts should be made.

We cannot state that after a more complete review of the project, our concerns will be limited to only the above six items but feel that they reflect our concerns at this time based on the limited information available to us.

I appreciate the opportunity to comment on the preliminary draft. Please feel free to contact me at any time regarding this or any other project.

Sincerely yours,

Wallace E. Stickney

Wallace E. Stickney, P.E.
Director
Environmental Policy Coordination Office

#1001

The Commonwealth of Massachusetts

Executive Office of Transportation and Construction

Department of Public Works

DISTRICT 2 OFFICE
NORTH KING STREET, NORTHAMPTON 01060

June 10, 1977

SUBJECT: Westfield-Local Flood Protection Program
NEDPL-R

Mr. Joseph L. Ignazio, Chief, Planning Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

In reference to your inquiry of May 26, 1977, directed to Rollin Petrin of this office, we offer the following:

We would not anticipate any significant environmental impact on our roadways as a result of your proposed work.

We wish to bring to your attention that this Department is presently under contract with Vollmer Associates to study the proposed relocation of Route 10 and its environmental affects. To aid and avoid repetition in your environmental data gathering process, we suggest that you contact our Boston office expeditor Frazier Hartley for any environmental data gathered by our consultant.

It has also come to our attention that the Massachusetts Department of Environmental Management Water Resources Division and the U.S.D.A. Soil Conservation Service is proposing eleven multi-purpose dams on the tributaries of the west branch of the Westfield River. Coordination with this flood retarding effort would appear prudent.

In closing we thank you for contacting us at this preliminary stage and extend to you our cooperation as needed in the future.

Very truly yours,

Francis J. Hoey

FRANCIS J. HOEY, P. E.
District Highway Engineer

Exhibit No. 18

REP/mkz
C - FH
ART

*The Commonwealth of Massachusetts*
*Water Resources Commission*
*Leverett Saltonstall Building, Government Center*
*100 Cambridge Street, Boston 02202*

XXXXXXXXXXXXXXXXXXXXX
DIVISION OF WATER
POLLUTION CONTROL

Water Quality and Research Section
P. O. Box 545
Westborough, Massachusetts 01581

June 6, 1977

Mr. Joseph L. Ignazio, Chief, Planning Division
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Ignazio:

Thank you for your letter of May 26, 1977 requesting our comments on the proposed flood control project in the City of Westfield.

Review of this project indicates that it will significantly alter the hydraulic characteristics of the Westfield and Little Rivers. This office used a mathematical model to determine the waste assimilation capacity of the Westfield River in the affected area. The proposed project may cause major changes in the assimilative capacity of the Westfield River. These possible changes in assimilative capacity should be addressed by the Draft Environmental Impact Statement.

This office will present a statement when public hearings are held on the Draft Environmental Impact Statement.

Sincerely,

Alan N. Cooperman

Alan N. Cooperman
Associate Sanitary Engineer

ANC/KTS/rg

Exhibit No. 19

*The Commonwealth of Massachusetts*

*Executive Office of Environmental Affairs*
*Department of Environmental Management*
*Division of Water Resources*
*Leverett Saltonstall Building, Government Center*
*100 Cambridge Street, Boston 02202*

OFFICE OF THE DIRECTOR

June 6, 1977

Mr. Joseph L. Ignazio
Chief, Planning Division
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Ma 02154

Dear Mr. Ignazio:

In response to your letter of 26 May 1977, I have reviewed the enclosed material relating to the Westfield Local Protection Project. We realize that much of the flood plain in Westfield is heavily developed and beyond the scope of what is presently conceived as feasible in terms of acquistion, relocation and certain other nonstructural measures. The environmental impacts of the use of structural measures, dikes, walls, conduits, etc., must, of course, be thoroughly evaluated.

We view the more obvious impacts to be:

1. The commitment of land to be the sites of dikes, walls, channels, and conservation (ponding) areas.

2. The direct visual impact of the structures and their shielding of the river from view.

3. The impact of channelization on fisheries resources.

4. The hydraulic and hydrologic short and long term impacts on upstream and downstream areas in terms of erosion, sedimentaion and elevated flood stages, and the impact on present and future uses of land affected.

5. The impact on protected areas behind the dikes in terms of the probable acceleration of development in areas now in open space or low density uses, and the impact on other areas which alternatively might have been developed.

6. The impact on natural river reaches which will no longer receive the erosive action of flood flows because of the use of diversion channels.

7. The impact on the disposal of sewage effluents on the artificial oxbow created during periods when flows are diverted from this reach.

8. The likelihood that the installation of this project will preclude the modification of the Knightville Dam and the impacts which will be thus avoided.

It is my general observation that a major planning effort should be conducted to integrate dikes, ponding areas and special land purchase, to comprise some sort of a linear parkway system (such as is being considered along the North Nashua in Fitchburg). Such a system of bike paths and small parks would go a long way toward mitigating adverse impacts.

A complementary nonstructural plan involving the City of Westfield should be adopted to insure that unprotected areas will not be adversely developed. This review is not to be considered as an exhaustive listing of environmental impacts, but rather a listing of those which appear most obvious after reading the material supplied with your letter.

Sincerely yours,

Emerson H. Chandler

Emerson H. Chandler
Chief Planner

EHC/gm

[illegible] OFFICE

[illegible] MASSACHUSETTS [illegible] 568-0316 413 568-5543

JOHN J. RHODES
MAYOR

May 2, 1977

John P. Chandler, Colonel,
Corps of Engineers
Division Engineer
U. S. Corp of Engineers
New England Division
224 Trapelo Road
Waltham, Mass. 02154

Dear Colonel Chandler:

I wish to inform you and the United States that the City of Westfield, Massachusetts offers its enthusiasm and willingness to contribute the financial assistance necessary for the completion of the proposed flood protection dike system intended to insure the safety of the lives and properties of its citizens. The City additionally agrees to the following assurances of local co-operation and participation prior to actual construction and will:

1. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction and maintenance of the project.

2. Hold and save the United States free from damages due to construction works except damages due to the fault or negligence of the United States or its contractors.

3. Maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of the Army.

4. Provide without cost to the United States all alterations and replacements of existing utilities.

5. Prescribe and enforce regulations to prevent encroachment on both the improved and unimproved channels, and manage all project related functions.

6. Comply with the provisions under Sections 210 and 305 of Public Law 91-646, 91st Congress, approved January 2, 1971, entitled "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970."

After considering the alternative non structural proposals regarding flood protection, the past, present and likely future patterns of development within the flood prone areas, and the historic incidences of flooding within the City, I have determined that the proposed dike

system remains the only practical solution for the future safety and welfare of Westfield's citizens.

I remain confident that the Congressional authorities will act favorably regarding the Federal participation essential for this proposal and consequentially to great benefit for the people of Westfield.

Very truly yours,

CITY OF WESTFIELD, MASSACHUSETTS

John J. Rhodes

John J. Rhodes, Mayor

JJR/slh

# City of Westfield, Massachusetts

**PLANNING BOARD**

June 23, 1975

Col. John H. Mason, Division Engineer
U. S. Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Col. Mason:

This is to inform you that the Westfield Planning Board, in full accord, endorses the concept of a dike plan for flood protection in the City.

The Board, at this time, however is reserving its opinion concerning the alternate plans presented thus far and wishes more time to further deliberate the proposals.

If the Planning Board can be of any assistance to you, please let me know.

Sincerely yours,

CITY OF WESTFIELD, MASSACHUSETTS

Walter B. Zygarowski

Walter B. Zygarowski, Chairman
Westfield Planning Board

WBZ:SEB

CC: Mayor John J. Rhodes
Patrick H. Dowd, City Council president

Exhibit No. 22

TOWN OF AGAWAM

# Conservation Commission

AGAWAM, MASSACHUSETTS 01001

April 1, 1975

Colonel John H. Mason
Corps of Engineers
Division Engineer
Department of the Army
New England Division
424 Trapelo Road
Waltham, Mass. 02154

Re: NEDPL-P

Dear Colonel Mason:

The study submitted by the Corps of Engineers of the project indicates that the impact would be site specific. The report does not mention the elevation of flood of record in Westfield - the basic reason for this project.

The Agawam Conservation Commission would ask specific answers be given to the impact that either of these proposals would have on the areas downstream.

We would ask about the possibility of increased volume and velocity or reduced stream flow caused by the probable divorcing of wetland and natural flood plain areas. Would the project have an effect on the present flood levels of the river through the Town of Agawam and at the confluence of the Connecticut River - where some 70 acres of flood plain are presently being divorced by diking - will these dikes be adequate? Would an increase in volume tend to erode the shore line areas in Agawam?

Finally, we ask if enough research has been done to indicate the feasibility of flood control by flood plain zoning acquisition of flood plain and wetland areas - both in dollars and environmental impact, as an alternative method of flood control?

Sincerely,

Dorothy A. Nelsen

Dorothy A. Nelsen
Chairman
Agawam Conservation Commissi

DAN/wem
Attachment

Exhibit No. 23

*The Commonwealth of Massachusetts*

*Executive Office of Transportation and Construction*

*Department of Public Works*

*Office of the Commissioner*

*100 Nashua Street, Boston 02114*

Col. John Mason
Corps of Engineers
424 Trapello Road
Waltham Mass.
Attn: Mr. Carmen Ciriello

Dear Sir:

The Department of Public Works is presently engaged in studies regarding the feasibility of relocating Route 10 from the Connecticut State Line in Southwick, northerly through the Towns of Southwick, Westfield and into Southampton. The Department is concerned about the probable impact of this project on the total environment. This concern pertains not only to the proposed construction corridor itself, but extends to all environmental conditions in the surrounding area for which a measurable impact may be foreseen.

We are requesting your attendance at a special meeting (workshop) of civic leaders, federal, state and local officials. The meeting will be held on Wednesday, July 16, 1975 at 4:00 PM in the auditorium of the South Middle School in Westfield. This meeting will be followed on the same date by a general public meeting (workshop) at 7:30 PM.

The meeting is being held to facilitate continued community participation in the transportation planning process. The presentation will include a report on the study findings to date and address the questions and issues raised at the previous meetings. It will be followed by a question and answer period during which those present will have an opportunity to present their views. Additional comments by mail will be welcomed and a form will be provided for this purpose.

Thank you for your interest in this project and its relationship to our environment. Your cooperation is appreciated, and it is my hope that you will be able to participate in this meeting on the date indicated.

Very truly yours,

Exhibit No. 24

Robert T. Tierney

Robert T. Tierney P.E.
Chief Engineer

# City of Westfield, Massachusetts

**PLANNING BOARD**

March 26, 1975

Col. John H. Mason
Department of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

SUBJECT: FLOOD PROTECTION - WESTFIELD, MASSACHUSETTTS

Dear Col. Mason:

I recognize the need for flood protection in the densely developed central low land areas of the City of Westfield and wish to go on record fully endorsing "Alternate Proposal Number 1" and its variation, "Alternate Proposal Number 4". I am convinced that future flooding disasters are imminent for which the City is not prepared.

Recognizing that proposals such as these can only come about after thorough investigation of all other feasible approaches, some of which would involve other communities, it does appear to me that Westfield has got to accept the fact that it must go ahead with this project and cannot depend on other communities for its own protection.

Since virtually all of the densely developed areas of downtown Westfield are prone to flooding, flood plain zoning in itself could not begin to remedy what has already been heavily developed through years of building; it therefore can really only affect new construction on those sites still open to development.

A repeat performance of the 1955 type flood at this time would have even more devastating effects than previous because of the significant amount of development that has taken place within the last twenty (20) years in the areas prone to flooding; also, those families struggling along with unemployment (presently over 10% in Westfield) and fixed incomes would be particularly hard pressed to repair their properties. Very likely in these financial situations these families would not choose to purchase Flood Insurance regardless of the minimal cost.

I also do feel at this time that the City's share of initial cost for this project is minimal when compared to possibly ten-fold this cost of water damage, destruction and hardship. Human life must be considered a priceless item.

Flood Protection - Westfield, Massachusetts

The Westfield Planning Board has decided to make a statement as a matter of record concerning your proposals and has placed this matter on its April 14, 1975 Meeting Agenda, immediately after which time a letter will be forwarded to you by the Chairman of the Planning Board, Walter B. Zygarowski.

I will be looking forward to working with the members of the Corps. during the Environmental Impact Statement stage and hopefully the design stages to make this project just right for Westfield.

Sincerely yours,

CITY OF WESTFIELD, MASSACHUSETTS

Leslie P. Brodacki

Leslie P. Brodacki, Senior Planner
Westfield Planning Department

LPB:SEB

CC: Planning Board Members
Mayor John J. Rhodes

# TOWN OF WEST SPRINGFIELD, MASSACHUSETTS

CONSERVATION COMMISSION

126 PARK STREET WEST SPRINGFIELD, MASS. 01089


1975 March 24

Proposed Westfield
Flood Protection

Col. John H. Mason, Division Engineer
U. S. Army Corps of Engineers
424 Trapelo Road
Waltham, Mass. 02154

Dear Sir:

After considering your presentation of the proposed flood protection project in Westfield, and making a field study of some of the downstream reaches of the river as well as making a few calculations from what maps and data we have readily available, we wish to present the comments below. We are sure that you will understand that these are made in the light of downstream interests, without attempting to assess the situation in our neighboring community.

We point out that in the 1955 storm "Diane" the river came within 0.6' of the top of the wall in the West Springfield dike system at River Street, as measured by a competent engineer. Admittedly, the Littleville Dam has since been added to the upstream protection system, but as an offset to this the backwater elevation from the Connecticut River at the time was less than might ordinarily be expected. Further, there seems to be significant new siltation in the river bed downstream, possibly arising from the several cofferdams built during the recent repairs on the Strathmore dam as well as from many other causes, which can only serve to raise the backwater elevation at this critical point.

Our rough computations indicate that the diking proposed in your Alternative I (the others have not been investigated) would exclude from the active river system perhaps $300 \times 10^6$ $ft^3$ of flood plain storage at the crest elevation of the 1955 flood, with nearly $1 \times 10^9$ being excluded at maximum elevation. Although this is equal to only one hour's flow according to the 1955 records and therefore is not of great importance to the general level of the flood waters, the behaviour in regard to damping out flood surges could be significant. Such surges, although difficult to analyze and predict, can be frequent in a narrow valley such as the present one and can propagate and intensify for great distances. They can lead to rapid flooding of areas which would otherwise remain dry, and to overtopping of structures which would otherwise remain intact.

With the loss of flood storage as is proposed, there would remain only three downstream areas which would afford any significant storage and surge-breaking capacity. The most important is the Adams Nursery peninsula just south of Route 20; next is the area across the river westerly from Adams Nursery;

and finally is the peninsula of Mittineague Park in West Springfield. The total capacity of these areas is not great, and would be insufficient to prevent an additional threat to the Nursery property, to the Mittineague Mills, and to the West Springfield dike system.

Beyond the consideration of flooding, there should be mentioned the additional problem of siltation. With extensive channelizing superimposed on the loss of storage capacity, the silt load in the river from upstream will inevitably be carried directly through Westfield to be added to the accumulations downstream. The deltaic flood plain in Agawam at the confluence with the Connecticut will be built up, raising the backwater level around West Springfield's southerly perimeter. If this be channelized, then the silt will be deposited in the Connecticut and create problems along the easterly perimeter.

We suggest that all of these effects should be included in any general evaluation of the proposed project, and feel that in the aggregate they will be found to be more than "minuscule".

Finally, we give you figures for the maintenance costs of the West Springfield dike system over a number of years, to illustrate that the expenditures have been on a planned and controlled basis. You are no doubt aware that municipal accounting makes no allowance for such items as pension costs, insurance, witholding taxes, general overhead. and the like; the quoted figures should be increased by 30% or more to obtain true costs. (All figures rounded)

| | | |
|---|---|---|
| 1972 | $47 000 | |
| 1971 | 40 000 | |
| 1970 | 41 000 | |
| 1969 | 42 000 | |
| 1968 | 34 000 | |
| 1967 | 31 000 | |
| 1966 | 31 000 | |
| 1965 | 40 000 | (diesel replacement) |
| 1964 | 38 000 | " " |
| 1963 | 26 000 | |
| 1962 | 23 000 | |
| 1961 | 25 000 | |
| 1960 | 25 000 | |

Very truly yours,

R. W. Vose

R. W. Vose
Chairman

The Commonwealth of Massachusetts
Executive Office of Transportation and Construction
Department of Public Works
100 Nashua Street, Boston 02114

February 28, 1975

John H. Mason, Colonel
U. S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02154

Dear Colonel Mason:

This office has reviewed the proposed local protection project on the Westfield River, Little Westfield River and Powder Mill Brook in the city of Westfield.

It is my opinion that alternative 1 is the best of the two proposals, and I strongly recommend that it be undertaken.

Twenty years ago the area proposed to be protected was farm and nursery land with few buildings on it. Construction of various kinds of building in the past years has created an enormous increase in property values and consequent financial loss in the event of another flood.

One can predict that a damaging flood is certain to occur that would flood large parts if not all of the developed flood plain, notwithstanding the fact that two flood control reservoirs are in existance upstream from the proposed dike system.

This river has had many large floods, the greatest being in 1955, there were several others between 1868 and 1938.

It would be greatly appreciated if this statement would be read into the record at your meeting to be held in Westfield on March 18, 1975.

Very truly yours,

Malcolm E. Graf

MALCOLM E. GRAF, P.E.
Associate Commissioner

Exhibit No. 27

OFFICE OF THE MAYOR

*City of Westfield*

*Massachusetts*

JOHN J. RHODES
MAYOR

April 1, 1974

Department of the Army
New England Division
Corps of Engineers
424 Trapello Road
Waltham, Massachusetts 02154

Dear Sirs:

In response to our meeting relative to the proposed Westfield local flood protection project, I am pleased to say our participation is now an official position of the City of Westfield, to participate in the proposed local flood protection project.

As you are well aware, the Westfield Planning Board has expressed its full desire to participate in such preliminary study. I am in full agreement with the need for a comprehensive flood control project in the community. Although I have some strong feelings toward the overall cost of this project, I am still willing to express an affirmative intent on such a project.

Sincerely,

John J. Rhodes

John J. Rhodes
Mayor

JJR/jfb

Exhibit No. 28

JOHN J. PALCZYNSKI
MAYOR

# OFFICE OF THE MAYOR

*City of Westfield*

*Massachusetts*

September 16, 1969

Mr. Tony Baglioni, Project Engineer
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

RE: NEDED-E -letters January 23, 1968 and September 15, 1969

Dear Mr. Baglioni:

This letter is in regards to a local protection project in Westfield, Massachusetts, which was authorized by the Flood Control Act, approved July 14, 1960, Public Law 645, 86th Congress, second session.

It is my understanding that under the law, the non-Federal interests, meaning Westfield, have until September 22, 1969, to furnish required assurances that the City would participate.

In the event you do not receive these assurances, the project authorization expires, and the City, in order to revive the project, would have to go through the process it did before, to obtain new Congressional Authorization.

Therefore, I respectfully request your assistance in asking for an extension of that date, to allow us the opportunity to review the project, to present it to local interests, business, civic and others, to determine whether the City would consider acceptance of it.

It is my considered opinion that this project should not be allowed to lapse and also that the political environment today would not permit action, but if the date were postponed, perhaps positive action could be taken.

Therefore, I strongly request and urge that assistance be given to extend the date for a relatively short period of time, perhaps for three (3) months, to allow further consideration.

Sincerely,

John J. Palczynski

John J. Palczynski
Mayor, City of Westfield, Massachusetts
JJP/e

Exhibit No. 29

WESTFIELD LOCAL PROTECTION
WESTFIELD RIVER
WESTFIELD, MASSACHUSETTS

# CULTURAL RESOURCE RECONNAISANCE

# APPENDIX 3

WATER RESOURCES INVESTIGATION

## PART I

## TABLE OF CONTENTS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SYLLABUS

This Appendix is in two parts. The first part describes the archaeological properties reconnaissance which was made essentially to provide an inventory of recorded sites, and also to locate in the field and assess these sites. The second part describes the reconnaissance which was made to locate any previously unrecorded sites, using document searches, field investigations, and personal interviews.

Work was performed by the Institute for Conservation Archaeology, Peabody Museum, Harvard University, Cambridge, Massachusetts, under contract to the New England Division, Corps of Engineers.

ABSTRACT

A cultural resource survey for the Westfield Local Protection Project, Westfield, Massachusetts performed the literature/archival search for the area to be directly disturbed along the Little River, Westfield River, and Powdermill Brook and field checked only those areas reported in literature and records as having prehistoric or historic cultural resource potential. Of the 14 sites checked, further study is recommended for 10 sites, 1 of which should be avoided as an irreplaceable historic site of public interest.

# I. INTRODUCTION

During October and November 1976, a cultural resource reconnaissance was made in selected areas along the Westfield River, Little River and Powdermill Brook in Westfield, Massachusetts; these areas are within the area to be disturbed by the proposed Westfield Local Protection Project of the Army Corps of Engineers, New England Division. The study was designed with four basic goals in mind:

1. To provide an inventory of cultural resources in areas to be directly impacted as they are described through published literature, archaeological and historical records and informants.

2. To locate in the field and assess known archaeological sites in areas to be directly impacted, within the restrictions of time and budget.

3. To provide an evaluation of the probable and potential cultural resources of the area.

4. To make specific recommendations regarding the future management of any cultural resources located.

This study was not designed to be a complete cultural resource survey. In specific, no attempt was made to locate sites in those portions of the area to be disturbed for which sites have not been previously known or reported. Further, at the time of this study, indirect impacts of the project (including staging areas, access roads, spoil areas, borrow areas and areas threatened by disruption of present current patterns) had not been determined or assessed and these areas were not treated. Finally, there were two sites in records which could not be field certified, since the amount of testing required would exceed expenditures commensurate to a feasibility study. Details on these sites can be found in Section V of this report, Sites M29-12 and M29-50.

## II. AREA IN REGIONAL CONTEXT

Figure 1 shows the boundaries of this study, the areas of direct impact of the project and the areas tested. As the meandering pattern shows, the study area is one where alluvial deposition is a dominant factor in shaping the face of the land. As will be documented later, alluvial deposits of 2 meters depth or greater are not uncommon in the area.

This alluviation situation has three important effects upon the archaeology of the area. First, with more earth to move, archaeological excavation takes longer. Excavation must continue until soils that were lain prior to local human activity are encountered; in early testing or later mitigation, as a general rule, the greater depth of recent soils requires more labor expenditure.

Second, with regular, sometimes annual, alluvial deposition, remains may be buried. In areas attracting repeated occupation, the result may be a stratified site, where various time segments are separated into discrete units by intervening alluvium. Such a situation is rare in Massachusetts and in the entire Atlantic Coast/Piedmont Province (q.v. Coe 1964).

Third, these fertile soils have attracted a high concentration of population at several time levels. In fact, this area of the Westfield River has one of the highest site densities in New England (Salwen 1969) and includes one of the most important sites in New England archaeology: the Guida Farm site (M29-83) (Byers and Rosue 1960). Historically, Westfield played an important role in the Euro-American settlement of the Connecticut Valley.

The remainder of this section will outline the culture history of the Middle Connecticut Valley, both prehistorically and historically, and relate it to the study area.

### Paleo-Indian

The only radiocarbon dated Paleo-Indian site in Massachusetts is Bull Brook in Ipswich. Unfortunately, their clustering around 7000 B.C. (uncorrected--Byers 1959) is now generally regarded as inaccurate due to the ca. 8500 B.C. dates obtained at the Debert site in Nova Scotia (q.v. MacDonad 1969). In any case, this tradition marks the first human occupation of North America.

Around the survey area, no fluted points, diagnostic of the Paleo-Indian tradition, have been found in Westfield proper. Fluted points have, however, been found in nearby Chicopee and Montague (Fowler 1951, Young 1969:38). The edges and beaches of glacial Lake Hitchcock (Hartshorn 1969) interestingly do not correlate with these finds, which all occur within the boundaries of the lake at its greatest extent. Consequently, no predictive statement can be made about the likelihood of finding Paleo-Indian remains in the study area, since the mechanism of deposition of known finds in unclear.

Early and Middle Archaic

These traditions bridge the temporal period from the end of the Paleo-Indian tradition to about 3500 B.C. In inland regions, the glacial recession brought a biotic community not conducive to human settlement (Fitting 1970:65ff.); Ritchie (1965:31ff.) documents the scarcity of Early and Middle Archaic materials in inland New York. In coastal areas, however, Dincauze (1976) has demonstrated that these traditions were maintained in New England, probably utilizing anadromous fish runs extensively.

The study area seems to fit the coastal pattern: it is only about 100 river kilometers from the ocean, lies on the coastal plain, and formerly hosted annual shad runs. Further, in the Edwin Smith Historical Museum, Westfield, there is an unprovenienced Stark point, diagnostic of the Middle Archaic tradition; presumably the point was locally collected. The settlement pattern to be expected during this time period includes sites at waterfalls on major rivers and unknown (drowned) coastal sites. No areas within the study area fit precisely these conditions, but areas of indirect impact downstream well might. Further, details of this settlement pattern are not well known and other settlement types probably exist.

Late Archaic

Within the Late Archaic period of Massachusetts, three traditions have been defined. The Laurentian tradition, characterized by Brewerton points, seems to be more a collection of traits or types which occasionally occur on sites of other traditions. While Ritchie (1969) has argued for this tradition, Dincauze (1975) has mounted a good case against it as a cohesive entity.

The Narrow Point tradition is known primarily from eastern Massachusetts and southern Connecticut, but its diagnostic features, Squibnocket points, are common in the Middle Connecticut

Valley (from viewing collections at the Springfield Museum of Science). While no comparable data are known from the Connecticut Valley, in eastern Massachusetts, sites of this tradition occur in an extensive range of environmental zones, greater than for any other prehistoric cultural unit (Dincauze 1975). On the basis of this information, sites of this tradition might occur anywhere within the study area where settlement would be possible.

The final tradition, the Susquehanna tradition, is presumed to be an intrusive culture from the south, which coexisted with the Narrow Point tradition from 2100-1200 (?) B.C. Their settlement pattern in eastern Massachusetts (Dincauze 1973: Map 3) shows a predilection for tributaries rather than main waterways. Collections at the Edwin Smith Museum show Susquehanna presence in the region. Consequently, the most likely zones for Susquehanna tradition sites might be Powdermill Brook and perhaps Little River.

At the end of the Late Archaic period, the orient phase became an important entity in southern Connecticut and Long Island, but in the Middle Connecticut River, Orient points remain a minority type. At this same time period, however, the Westfield region became important to southern New England as a whole by virtue of its steatite resources. These sources were mined at Wilbraham and Westfield (west of the survey area) and perhaps elsewhere by Indians of unknown cultural affiliation (q.v. Fowler 1943, 1956, 1961, 1968). The products, either raw or finished, were then traded around southern New England.

No steatite quarries can be expected along the area to be impacted, since the steatite occurs in the hills, rather than in river valleys.

Early Woodland

There are no well-founded dates for this tradition in western Massachusetts, but Ritchie (1969:231) has an uncorrected radiocarbon date of 590 B.C. for the related Lagoon complex of Martha's Vineyard.

In the Westfield region, Willoughby (1935:83-84) and Young (1969:52-56) have reported the Holyoke Depot site. This burial site contained skeletal material plus the diagnostic blocked-end tubes, beads, and Meadowood points of this tradition. Like most Early Woodland cemeteries, this site was located on a high terrace overlooking a river. Several areas within the study area, especially the high terraces to the north of Powdermill Brook (near M29-94), to the north of Westfield River (near M29-82), to

the south of Westfield River near Meadow Street, and to the south of Little River in Feeding Hills.

Beginning with Early Woodland, the settlement pattern dominant through Euro-American invasion is set. Large habitations are predominantly in elevated flood plains and smaller camps are further back on smaller streams; a seasonal transhumance explanation is likely, but undemonstrated. The entire elevated portion of the study area, those areas about 3-5 meters or more above mean water level, is prime land for the larger (summer?) sites. Other factors, such as adjacent farming land (Late Woodland and Historic), fishing areas, and the like still make evaluation of site potential possible.

## Middle Woodland

While this tradition, lasting perhaps 0 A.D. to 850 A.D. is poorly known in most of New England, it is relatively well known regionally because of the Guida Farm site (M29-83). This site on the Westfield River is located on a high terrace and is a large site. (Further details on Guida Farm are given later in this report.)

## Late Woodland

There is also a Late Woodland component at M29-83. In the Late Woodland tradition, maize agriculture was a mainstay of culture and villages (in the latter portions) had become permanent and year-round. The Middle Woodland can be seen as a nonagricultural transition from Early to Late Woodland in terms of sedentism. Obviously, with increasing sedentism, the need for high ground for villages became more intense; as will be seen, in the historic period and probably the Late Woodland period as well, defense was also a factor in settling on high ground. The agricultural base, however, demanded that fields be periodically rejuvenated by flooding, so high ground above major flooding rivers became premium in settlement locations. Such areas within the project area would be the Westfield River (north bank around M29-82, M29-83; south bank around M29-65); other areas would be of secondary likelihood.

## Historic-Aboriginal

The Late Woodland period grades imperceptibly into the Historic period with the coming of Europeans. Young's (1969:40-47) description of the Long Hill site in Springfield clearly shows a contact period aboriginal site (although his Plate III includes Late Archaic Squibnocket Stemmed points as well, presumably from

another component at the site).

The aboriginal culture of this period is intricately interwoven with European culture. In 1632, William Pynchon was given exclusive rights to fur trading in the Middle Connecticut Valley by Massachusetts Colony. In 1636, Pynchon and a group of settlers from Roxbury set up a settlement at Springfield, specifically aimed toward fur trading. Pynchon's avowed policy was to extend credit to Indians, indeed to overextend credit, then to retain their economic dependence upon him and his trade (Barnett 1968:27). In Westfield itself, then known as Woronoco, a trading post was set up in 1639; the exact spot is unknown, but arguments have been presented for the confluence of the Little and Westfield Rivers (Flahive 1968:344) and for "where the County Bridge now stands" in the Little River section of town (Pitoniak 1968:455-456). Further, a plaque places the post on a Main Street and local traditions place it at the base of Feeding Hills.

As a result of the post and Pynchon's economic strategy, Indian settlements were drawn very close to European settlements, literally in traders' yards if possible (Lockwood 1922: v.1, 200) Furthermore, the sporadic New York Iroquois raids which persisted presumably from prehistoric times fostered settlement near Europeans for defense. Trading became more adaptive than farming and men would leave settlements for several week trapping trips.

By 1660, economic dependence of Indians on Europeans, coupled with increased European recognition of their settlement as permanent led to the cession of lands by Indians to Europeans. At this point, records were made of territories of the local Algonquian Indians, known collectively as Woronokes. Figure 2 is drawn from Dewey (1905), and Taylor and Whitney (1794) and shows what is known of aboriginal holdings at this time.

King Philip's War in 1675 never touched Westfield directly, but the Springfield Massacre raised European animosity and most Indians left the region shortly thereafter. Aliquat's final cession of all Indian lands to the Europeans in 1684 was a postcript to a message which had been clear for nine years: aboriginal presence in Westfield was dead.

<u>Historic-European</u>

As stated above, Euro-American settlement around present Westfield began with the trading post of 1639. General settlement began around 1658 when personal land grants were begun, although throughout the seventeenth and eighteenth century the majority of land around Westfield was in common meadow. Figure 3 shows these

meadows, which include nearly the entirety of the survey area.

Domestic settlement during this early period followed the two major routes of travel: the Springfield Road (present Main Street) and to a lesser extent present Union Street (laid out in 1668--Dewey 1905). The center of town began around the confluence of the Little and Westfield Rivers and shifted to its present location at the western end of Main Street only around 1790, when the industrial revolution shifted Westfield's emphasis from farming to industry and shops (Harding 1968:107). The north side of the Westfield River was populated by lower class persons and until the coming of the railroad in 1841, records are few and poor (Searle 1968:403). The political entity of Woronoco (later Streamfield, later Westfield) was established in 1670 (Barnett 1968:34); the population rose from nearly 500 in 1689 (Jones 1968:77) to about 800 in 1754 and 2219 in 1790 (Harding 1968:107).

The earliest recorded mill in Westfield is the gristmill on lower Powdermill Brook (then Sackett's Creek), of the survey area, but Flahive (1968:345) states that in the eighteenth century, light industrial mills could be found on "any little stream that could turn a wheel." Flood potential of the larger order rivers, especially the Westfield and Little Rivers, hindered their use for milling power and no mills were noted in sources consulted, with the single exception of a 1790's (?) hemp mill at the south side of the Westfield River at lower Union Street (Flahive 1968:348), which may be on the survey route. Small mills seem to have been more common on the north side of town (Searle 1968:403).

In the 1820's and 1830's Westfield was swept with the canal enthusiasm epidemic in New England. A feeder canal to the Hampden Canal (called the Farmington Canal in Connecticut) cut across the south edge of town as shown in Figure 3 (Lockwood 1922: v.2, 282ff.).

In summary, until an indeterminate time in the mid-1800's to early 1900's, domestic settlement in Westfield avoided the survey route. Mills, however, may well be along it and the old canal lies along part of the survey area.

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## III. METHODOLOGY

This study is divisible into two phases: literature and records search and field checking. In practice, the two phases were interspersed to allow efficient usage of time and cross-checking of information, but the literature and records search generally preceded the field checking. Since this study was not designed to include survey of the entire route, only areas of known sites were investigated.

During the literature and records search, the following sources were consulted:

1. Records at the State Archaeologist's office, the Massachusetts Historic Commission, the Westfield Municipal offices, the Department of Anthropology at the University of Massachusetts (Amherst), the Department of History at Westfield State College, the Springfield Museum of Science, and the Edwin Smith Historical Museum.

2. Local authorities in history and archaeology: Dr. Dena Dincauze, Dr. Weston Dyer, Dr. Maurice Robbins, John Pretola, Harold Mashin, Peter Thomas, and Thomas Ulrich.

3. Published literature in archaeology and history, included but not limited to those sources cited in the bibliography.

4. Old maps as available.

Attempts were made to consult local avocational archaeologists, but none could be located.

Particular note should be made of Westfield Historic Commission records, provided as Appendix B to the Scope of Work. Neither the houses listed therein nor those listed in Salmond (1958) lie within any portion of the survey area.

During the field checking of reported sites, methods were, of necessity, various. The location of designated area was troublesome, due to severe errors of location on the map provided as Appendix A of the Scope of Work (*vis-a-vis* site records elsewhere for the same site numbers, both cartographic and verbal), vagueness in descriptions and changing landmarks. The basic strategy was to begin work in areas of overlap between the described extent of the site and the location of proposed construction. Failing location of the site, neary areas deemed

subjectively likely as habitation areas (based on known settlement pattern) were examined. The distance to which this procedure was carried was in direct relation to the vagueness of the location description.

Upon locating an area to be examined, surface collection was made wherever development and vegetation cover allowed. If surface remains were encountered, they were mapped and collected and no subsurface testing was undertaken. This method was the most economical possible to satisfy the primary goal of location and secondary goal of assessment.

Failing surface finds, subsurface testing was necessary. If possible, banks or slopes were straightened to obtain profiles to evaluate flooding, filling, and erosion history; in some cases, these were enlarged to attempt the collection of cultural materials. If banks were not available, 1 m. x 1 m. test units were excavated. This size was chosen since a smaller size could easily miss the sparse artifactual materials found on many aboriginal sites in the region; a larger size would have been prohibitive for time expenditure. Excavation was made with shovel or trowel as seemed advisable in terms of logistics and endangering of retrieval; when practical, all materials were sifted with quarter-inch (6 mm.) mesh sifters. Areal maps and test unit profiles were drawn and notes were taken. Mapping methods included compass triangulation, aerial photogrammetry, and sketch mapping. All sites were located on the Universal Transverse Mercator Grid (UTMG).

The efficacy of these methods justifies them. Of 13 aboriginal site locations recorded, 12 were located in the field; the thirteenth was apparently a spurious or inaccurate record. Of those 12 sites, 10 sites were located (7 in the survey area, 1 other destroyed totally, 2 off the survey area); the remaining 2 sites are probably in the locations described, but could not be located in the large, vague area described. The only historic site located in the literature and records search was located and confirmed in the field. (Details of these sites are given in Section V.)

## IV. PREVIOUS RESEARCH

Archaeological research in the survey area is minimal. Brooks (1946) excavated and reported on burials and habitation materials from either M29-83 or M29-104. (Indeed, the two "sites" may be different ends of the same site.) Byers and Rouse (1960) excavated and reported on M29-83 (Guida Farm site) and isolated Middle Woodland and late Woodland components. On the basis of the ceramics, they postulated the area as the center of a major southern New England diffusion network. They believed their excavations discovered house floors, which seems likely. Howes (1960) believed he saw Vinette I pottery (indicative of Early Woodland) in the collection, but Byers and Rouse (1960:24) rightfully disagree. Young (1969) conducted further excavations on M29-83, finding further burials and habitation features.

With these exceptions, no other sites in the survey area have been researched and reported. These excavations all reflected competence for the techniques in general use at the time, but the Byers and Rouse work is the only research thoroughly reported. Furthermore, many techniques presently in common usage (e.g., radiocarbon dating, flotation, botanical analysis, faunal analysis) were not used in these projects, either due to not having been developed or popularized or due to having posed prohibitive expense. While sound work in their times, these works have all been outstripped by modern techniques.

## V. CULTURAL RESOURCES ENCOUNTERED

This section summarizes cultural, environmental, and locational information about the sites tested. Since site maps and soil profiles are included in the figures, much redundant information has been omitted in this section.

M28-10

Previous Finds: "Quartzite cores and flakes"--William S. Fowler.

Comments: The greater portion of the reported site area lies under the parking lot or existing streets; only a small portion of woods and a small terrace on the riverbank remain undeveloped.

Surface Collection: Impossible due to vegetation.

Excavation: Test Unit 1 was a 1 m. x 1 m. square on the small terrace.

Stratum 1: Duff. Brown glass beer bottle fragments, clear glass soda bottle glass fragments, plastic spoon fragment, part of a plastic toy. 0-5 cm.

Stratum 2: Gray sand. Cinders, clear soda bottle glass fragments, two large pieces of a milk bottle imprinted from New York City, brown glass beer bottle fragments, pieces of thin (ca. 0.1 cm. diameter) iron wire; charcoal lens near bottom. 5-103 cm.

Stratum 3: Relict turf line. Two pieces of the milk bottle in Stratum 2, two pieces of glass brick (?), a purpled base of a clear glass soda bottle, most of an iron tobacco can, several pieces of barbed iron wire, several pieces of thin yellowed celluloid. 103-108 cm.

Stratum 4: Gray/yellow sand. Several pieces of a modern clear glass whiskey bottle, clear glass soda bottle fragments, a brown glass beer bottle fragment, a piece of clear glass light bulb, pieces of thin yellowed celluloid, pieces of barbed iron wire. 108-183 cm.

Stratum 4B: Soil as in Stratum 4. Sterile, but the top of this stratum was marked by a layer of unsorted rounded rocks (1-20 cm. diameter). 183-212 cm.

Stratum 5: Unsorted glacial till, including large cobblestones. Sterile. 212-215 cm.

Test Unit 2 was a 1 m. x 1 m. square atop the uppermost terrace in the woods.

Stratum 1: Duff. Large tarmac fragments. 0-8 cm.

Stratum 2: Coarse gray sand. Brick fragments, structural mortar, tar shingle fragments, cinders, clear bottle glass fragments, sheet iron. 8-29 cm.

Stratum 3: Orange/brown sand. Tarmac fragments, brick fragments, cinders. 29-59 cm.

Stratum 4: Fine gray sand. Sterile. 59-100 cm.

Stratum 5: Orange/brown sand, highly compacted at top. Sterile. 100-167 cm.

Stratum 6: Unsorted glacial till. Sterile. 167-169+ cm.

Excavation ceased at 169 cm.

Interpretation: The first two strata in Test Unit 1 show only very recent materials. Stratum 3, however, contained the base of a probably 1930's bottle which had been exposed to prolonged sunlight. The materials from 183 cm. upward were deposited since the 1930's, probably in the large 1936, 1939, and 1955 floods. Beneath these strata only sterile materials occurred, but the small terrace seems to have built up recently; the slope at 183 cm. was $32^{o}$--too much for convenient settlement. Test Unit 2 also revealed only secondarily deposited recent artifacts in terms of differential hydrological situation. Considering the site location described in the records and the results of these excavations, it seems most likely that M28-10 lies further west, under the parking lot and intersection.

Recommendation: The parking lot and intersection should prove an effective cap and since the construction is planned downstream of that location, no further study of this site is deemed necessary.

M28-11

Previous Finds: Unknown.

Comments: A small (ca. 10-15 cm. high) ridge between the

field and woods seems to be the result of plow castings. A possible canal bed lies further to the south about 25 m.

Surface Collection: The entire area of the corn field was systematically surveyed with parallel swaths at 4 m. intervals. The site map indicates the maximum extent and extent of concentration of the aboriginal materials encountered. These materials included: 1 quartzite core (11.5 cm. long), 2 pieces quartzite debitage, 14 pieces quartz debitage, 7 pieces Normanskill chert (from the Hudson Valley), 2 possibly utilized shale pieces, 1 piece of fire cracked rock, and 2 pieces of burnt bone (unidentifiable). Diagnostic materials consisted of 1 rhyolite endscraper, 1 quartz grave, 1 notched pebble netsinker, and 2 bases of large (ca. 4 cm. long) untyped triangular point bases. The overall assemblage is late Archaic, showing evidence of trade to the east (rhyolite) and west (Normanskill chert). Clam shell was scattered over the entirety of the field and seems to be the result of fertilizing. Recent historic artifacts were concentrated in the easternmost portion of the site.

Excavation: No excavation was made.

Interpretation: This site seems most likely to be a seasonal settlement of the Late Archaic (ca. 2100 B.C.) where several functions were being done: hunting, stone working, and probably others.

Recommendation: This site is important because of its apparent single component nature, its apparent lack of major disturbance, and its relatively large areal extent. Further study must be made to establish the true extent of the site, its degree of disturbance, and its general content. The change of flood flows after dike construction would threaten this site.

M29-3

Previous Finds: Unknown.

Comments: The area is favorable to settlement with a small brook intersecting the river and a rill to improve fishing, but most of the area is severely disturbed by the railroad, including grading and blasting. The only possibly intact area is the small terrace.

Surface Collection: Difficult, but possible in many areas. Banks, rodent spoils, and clear ground showed no signs of cultural activity.

Excavation: Test Unit 1 was 1 m. x 1 m. square in the central portion of the terrace. Since the profile is indicated in the figures it is not repeated here. No artifiacts (other than recent ones in the duff stratum) were encountered.

Interpretation: There is locally reported a site on the hill to the west; the site is within the shaded area on the State Archaeologist's maps. It seems most likely that M29-3 is in this upland location and outside of the area endangered by rerouted flood flows.

Recommendation: No further study is deemed necessary.

M29-12

Previous Finds. Unknown.

Comments. Between the knoll and the spoildike is a 3 m. wide swath which seems at least superficially disturbed on the basis of unclear soil junctions, lack of old tree growth, and topography. Whether the knoll was disturbed in construction of the spoildike is unclear.

Surface Collection: Impossible due to dense vegetation cover.

Excavation: Test Unit 1 was cleared bank on the south side of the knoll. Their profiles are given in the figures and will not be repeated here; all strata were sterile.

Interpretation: Indistinct soil junctions and larger rocks in otherwise well sorted alluvial deposits suggest disturbance. Within the allotted schedule, testing complete enough to locate a site or the extent of disturbance was impossible.

Recommendation: Further testing of the knoll, preferably with mechanical assistance to minimize time expenditure, is recommended. A random or systematic sample of the knoll is suggested as both thorough and efficient.

M29-50

Previous Finds: Skeleton plus other unknown finds.

Comments: The area within 30 m. of the river is heavily disturbed by land moving. To the east, land is lower. On the terrace above the eastern lowland, 8 circles of dark green vegetation (in November), about 3 m. diameter each, occur.

Surface Collection: Possible only in the heavily disturbed areas, where only recent artifacts were found. Elsewhere, vegetation precludes surface examination.

Excavation: Test Unit 1 was a cleared and excavated bank; Test Units 2 and 3 (in a dark green circle) were shovel sondages on the terrace to the east and west of the heavily disturbed area. Their profiles are given in the figures and are not repeated here; only recent artifacts were found.

Interpretation: While Test Unit 1 was clearly disturbed from the topography, the profiles of Test Units 2 and 3 show them to be in undisturbed but plowed alluvium.

Recommendation: The site may have been totally destroyed, but further testing, preferably rapidly by mechanical means, is recommended in the terrace to the east and west.

M29-62

Previous Finds: "Sinkers, soapstone, contact material, 1 scraper"--William S. Fowler.

Comments: The "contact material" in Fowler's sites rarely materializes in the field.

Surface Collection: Surface collection over this huge area was partly systematic (4 m. swaths along the outer 20 m. of fields), partly random, and partly nonrandom (examination of dark soil areas). Located on the site map are the 6 finds: 2 quartz flakes, a possible quartz core, 2 heavy quartz tools and a Normanskill chert flake.

Excavation: None.

Interpretation: None of these materials is diagnostic of particular culture(s) or period(s), but they do indicate a prehistoric site. Absence of pottery suggests an Archaic date.

Recommendation: Further testing should be undertaken to determine the nature and extent of this site.

M29-82

Previous Finds: Burial with quartz, quartzite, and chert flakes and "considerable contact material"--William S. Fowler.

Comments: The bank puts this area above all but the most

extreme floods.

Surface Collection: The sand pit and pipe storage areas could be surface collected but no artifacts were found.

Excavation: Test Unit 1 cleared a portion of the high bank near the river.

Stratum 1: Duff grading to loam. This stratum slopes with the surface, suggesting stability for the present topography. Sterile 0-17 cm.

Stratum 2: Light tan sand. Sterile. 17-59 cm.

Stratum 3: Black organic soil. Close examination reveals carbonized seeds and charcoal flecks, indicating a midden. The stratum tapers out at 18 cm. horizontally from the slope surface. 59-68cm.

Stratum 4: Brown sand with pebbles. An aboriginal chert flake at the top of this stratum probably intruded from Stratum 3 via a rodent burrow noted in this stratum. 687-114 cm.

Stratum 5: Unsorted glacial till. Sterile. 114-131+ cm.

Excavation ceased at 131 cm.

Interpretation: M29-82 is apparently a habitation site, extensive if the midden accumulation is indicative. The extent of midden, proximity to surface in an alluvial area, and location argue for a permanent Late Woodland village.

Recommendation: This site appears to be an extensive and important village site. Further testing to determine its extent and nature is imperative.

M29-83

Previous Finds: Middle and Late Woodland components excavated by Brooks (1946) in the north, Byers and Rouse (1960) and Young (1967) in the central and south portions.

Comments: The area is heavily alluviated and despite loam removal operations (before Byers and Rouse's and Young's field work) the site remains largely apparently undisturbed.

Surface Collection: The area within 80 m. of the car sales place was surveyed systematically (swaths every 4 m.); the

remainder of the field was surveyed randomly and nonrandomly by transects. Cultural materials recovered were: Fire-cracked rock, 4 pieces quartz debitage, 8 pieces New York chert debitage, 1 utilized quartzite flake, 1 possibly utilized quartzite pipe, 1 piece of fired clay (amorphous) and 1 mica tempered sherd (Guida type). These materials were restricted to an 80 m. radius southeast from the car sales place as shown in the site map.

Excavation: None.

Interpretation: This surface collection can add little to the published accounts on this site, other than affirming its continued existence. With deep alluvium, surface distributions can be misleading.

Recommendation: The importance and nature of this site are known, but further testing is necessary to establish the limits of the site, a task never undertaken by earlier researchers.

M29-92

Previous Finds: 1 gouge, 1 chipped axe, 1 ground axe (William S. Fowler).

Comments: We were unable to locate this site area, since the area described is wetlands (and is for many meters along the brook). Consultation of 1944-45 and 1895 topographic maps show essentially the same contours, but no nursery. Residents consulted could recall no nursery ever having been in the area or in any nearby areas.

Recommendation: The site seems to be either spurious or severely mislocated. No further work is recommended.

M29-94

Previous Finds: "Contact material, fire stone, chips"--William S. Fowler.

Comments: Fowler's use of "contact material" is unclear.

Surface Collection: The entire plowed area was searched systematically with swaths at 4 m. intervals. In the eastern third of that area, as indicated on the site map, cultural materials were found. 5 quartzite flakes, 1 Normanskill chert chip, and a bifacial tool of dark gray chert were found.

Excavation: None.

Interpretation. No temporal or cultural assignment is possible.

Recommendation: Further testing is necessary to determine the nature and extent of the site.

N29-104

Previous Finds: Quartz and chert chips, 1 Squibnocket Stemmed point--by the author previous to this project.

Comments: Previous study of this site showed it to cover most of the lawn portion (and perhaps more) for the eastern 40 m. of the lawn area.

Surface Collection: The area is in lawn and surface collection is impossible. The spoil from a newly bored telegraphy pole hole yielded 2 utilized quartz flakes and 2 matching pieces of an undecorated grit-tempered potsherd.

Excavation: None.

Interpretation: The Squibnocket point is late Archaic; the potsherd is (Middle?) Woodland. According to Don Helliwell, the area has "very deep" loam which is basically undisturbed: no major earth moving, only shallow plowing. As such, it may well be a stratified site, conceivably with other components.

Recommendation: Deep testing must be carried out to determine the nature of the site and its stratification and its extent.

M29-113

Previous Finds: "2 broken flint knives, chipped trap axe, red paint, contact material"--William S. Fowler; "many arrowheads."

Comments: The property was looted, apparently thoroughly, by "hundreds" of curio seekers after they first found artifacts in landscaping. Although digging went deeper, all finds were said to be in the top 6 or 7 inches (10-12 cm.) of soil. Artifacts are said be found occasionally.

Surface Collection: Impossible due to vegetation cover.

Excavation: Test Unit 1, the clearing of bank, is described in the figures, as is Test Unit 2, the opening of a section of the

edge of the earthen platform. Both units were sterile. Test Unit 1's profile indicated an alluvial formation (sorting, multiple stratification); Test Unit 1, with its complex, almost basket-load structure, appears artificial. Test Unit 3, a 1 m. x 1 m. square off the platform, also produced an alluvial profile:

Stratum 1: Duff. Sterile. 0-4 cm.

Stratum 2: Mottled orange/brown sand. 4 square iron nails (too rusted for dating) and a piece of bubbly thin amber glass from a vessel occurred near the top of the stratum, an aboriginal chert chip near the bottom. 4-22 cm.

Stratum 3: Light yellow sand. Sterile. 22-32 cm.

Stratum 4: Dark brown silt. Sterile. 32-478 cm.

Stratum 5: Orange glacial till. Sterile. 47-57 cm.

Excavation ceased at 57 cm.

Interpretation: The finding of apparent alluvial profiles this far from the river is not surprising, since inspection of a topographic map shows that the course of the Little River once followed the base of the hills. The chert chip near the bottom of an alluvial stratum suggests prehistoric date; the Little River was in its present course when the first Euro-Americans arrived.

Recommendation: The area should be tested further to determine the nature and extent of the site and the degree of disturbance.

M29-65

Comments: While mentioned in the Scope of Work, this site actually lies up a hill and away from the proposed project. Consequently, it was not field checked.

Recommendation: No work is necessary on this site.

Feeder Canal

Location: 10 m. south of the terminus of Towpath Land (dead-end street).

Owner: Robert Oleksak, Oleksak Lumber, Main Street, Westfield, Massachusetts.

Present Land Use: Woods.

Previous Finds: None Known.

Comments: The canal has been discussed earlier. This particular segment of the canal has special significance, as it is the only segment still existent.

Surface Collection: No artifacts were visible from the surface (the ground is covered by vegetation).

Recommendation: if possible, the canal remnant should be preserved intact. Failing that course, at least a portion should be preserved. Minimally, intensive archival research and field testing should investigate the nature of the earthen platform.

## VI. IMPACT OF THE PROJECT

Figure 4 presents my estimation of cultural resource potential within the various portions of the survey route. While based on defensible factors--known site densities, known settlement patterns, and known disturbance--the weighing of these several factors is subjective. Consequently, the result should be viewed as a general guide, not an oracle. The most noteworthy consideration is that the potential ranges from high to extremely high, a direct reflection of the generally high archaeological sensitivity in major river valleys around Westfield.

Known impacts of the proposed Westfield Local Protection Project to the sites dealt with in this study are considerable. Sites M28-30, M29-82, M29-94, M29-104, M29-113, and the Feeder Canal would be squarely on the route to be disturbed. Sites M29-12 and M29-50 have not been located and might be impacted.

While all of the archaeological sites can be preserved through excavation and information retrieval, the Feeder Canal is an historic site of a value beyond information. It exists as a monument clearly visible to any interested parties and cannot be replaced by a volume describing and interpreting it.

Finally the impacts beyond the areas studied in this report would be great. The following is a partial list of additional areas which will need to be investigated for cultural resources: areas on the survey route but with no reported cultural resources, borrow areas, staging areas, access roads, spoil pile areas and areas downstream and across-stream whose erosional potential will be increased by diverted and/or accelerated flood flows.

## VII. RECOMMENDATIONS

Recommendations have been given in Section V, but they will be detailed here. These recommendations fall into four groups:

Group 1: No further study necessary. Sites M28-10, M28-11, M29-3, M29-92.

Group 2: More study needed to locate site. This group includes cases where the small amount of fieldwork possible in this phase of study was insufficient to locate the site, yet where there are no reasons to believe the site is mislocated or destroyed. The suggested method for further locational testing is to employ mechanical equipment, perhaps augers, in a random or systematic sample over the portions of the site areas suggested in Section V. Sites M29-12, M29-50.

Group 3: Site located, more study needed to determine extent, depth, nature, and disturbance. As might be expected for a study locating reported sites, this group is the largest of the four categories. In some cases, site extents are suggested on the basis of surface distributions of cultural materials; but in areas of deep alluvium, such distributions can be misleading. Of the 7 sites in this group, surface or subsurface indications show 4 sites to be within construction boundaries, 2 sites to probably be within construction boundaries, and 1 site to be within the cross-stream flood wash. The information on nature and disturbance are important in assessment of site importance for future possible mitigation of project effects; the extent, depth, and nature are important in designing reasonable logistic schemes for testing and possible future mitigation. Suggested methods for dealing with the sites in the next phase of study include mechanical means for removing overburden, test excavation (manual and/or mechanical) for primary information retrieval, and augering or coring for determining site extent. Chemical testing, especially in conjunction with coring or augering, might also provide useful information, but it should be used with discretion. Sites M29-82, M29-94, M29-104, M29-113 within construction boundaries; sites M29-62, M29-83 probably within construction boundaries; site M28-30 within the cross-stream flood wash.

Group 4: Site should be avoided wholly or in part, if possible. The feeder canal is a visual resource the impact upon which cannot be fully mitigated by excavation. If the canal is not avoided, however, it must be intensively tested. This testing should coordinate with appropriate archival records.

In any future study, the field notes of this project should be consulted, since they contain much detail not given in this report. In addition to the recommendations for future study made above, the areas outlined in the last paragraph should be surveyed.

Finally, while the Scope of Work required paleontological reconnissance of the project area, that task was not undertaken. An archaeologist is not a paleontologist and does not possess his specialized knowledge; paleontology is not cultural in any sense and should not be a part of a cultural resource survey.

## VIII. SUMMARY

This study consisted of literature/records search and field checking of previously reported archaeological and historical sites. It was not a comprehensive cultural resource survey of the entire area to be disturbed by the project.

During the course of the survey, 14 sites on the survey route were located in records. 13 of these sites were field located; of those 13, 2 were found to lie actually off the survey route, 1 was totally destroyed, 2 were unconfirmed and require more intensive testing, and 8 were confirmed and require intensive testing. The survey area as a whole is judged to have very high archaeological potential.

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PART II

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'EDITOR'S NOTE

Readers of this repcrt are advised of a recent change in terminology, recommended by the National Park Service. Archaeological sites, both historic and prehistoric, are no longer to be termed cultural resources, but will be referred to collectively as archaeological properties. The term is neutral with respect to the time period of the site or property described.

## ABSTRACT

This report describes a Phase I/Reconnaissance Archaeological Properties Survey conducted on the site of the proposed local protection project in Westfield, Massachusetts. The study involves a search of historical documents to locate and evaluate historic sites within the project area, as well as an ecological analysis of the project area to assess the potential existence of prehistoric sites likely to be impacted. Persons knowledgeable in the history and prehistory of the area were consulted.

The study concludes that there are twenty-one sites or potential sites in which archaeological properties are likely to be adversely affected by the project. In addition, two densely overgrown areas should be surveyed more intensively during the early spring or late fall when vegetation will be at a minimum. Survey access was denied in one area that should be surveyed in the next phase. It is recommended that twenty-one and one-half days be devoted to intensive prehistoric survey and four and one-half days to intensive survey of historic sites.

## ACKNOWLEDGEMENTS

The authors wish to acknowledge the help of Dr. Dena F. Dincauze of the Department of Anthropology at the University of Massachusetts for her advice on the prehistory of New England; Peter Thomas for his advice on contact period property boundaries, deeds, and prehistoric settlement patterns in the Westfield area; Dr. Joseph Hartshorn of the University of Massachusetts for his advice on the geology of the Westfield area; Dr. Suzanne Elliot for her assistance in identifying historic artifacts; and Robert Drinkwater and Cass Mason for their advice concerning historic sites within the project area. We are indebted to all of the local historians and other interested persons for their help in locating historic properties, and the landowners for their kind permission to survey their property.

## INTRODUCTION

This report describes a Phase I/Reconnaissance Archaeological Properties Survey conducted for the U.S. Army Corps of Engineers over the site of the proposed Local Flood Protection Project in Westfield, Massachusetts (Fig. 1), in conjunction with the Institute for Conservation Archaeology at the Peabody Museum, Harvard University, Cambridge, Massachusetts. The survey was conducted by Mitchell T. Mulholland and Kenneth Quilty of the University of Massachusetts at Amherst. The field and lab crew consisted of Pamela Bumstead who served as soils expert, Michael Shott, Alan Strauss, Patricia Vonda, Margaret Keith and Debbie Frank.

Data on the setting and history of the project which customarily accompany reports such as this, and include categories such as geology, biota and New England and project-area prehistory have been omitted from this report as this contract is the second part of the Phase I survey contracted by the Institute for Conservation Archaeology and is to be considered as an addendum to the report by Barber (1976). If background information is desired, the reader is asked to refer to that report. Detailed data too lengthy to be included in this report, such as field notes, artifact catalogs, detailed survey-unit maps, collection catalogs, photographs and historic site data are being maintained on file at the Institute.

The survey fulfills the initial archaeological requirements under the National Historic Preservation Act of 1966 (PL 89-665, 16 USC 470); the National Environmental Policy Act of 1969 (PL 91-190, 42 USC 4321); Executive Order 11593; Preservation and Enhancement of the Cultural Environment, 1971 (36 FR 8921); Preservation of Historic and Archaeological Data, 1974 (PL 93-291); The Advisory Council on Historic Preservation's Procedures for the Protection of Historic and Cultural Properties (36 CFR VIII Part 800); and Identification and Administration of Cultural Resources, 1975 (EC 1105-27).

The purpose of a Phase I/Reconnaissance Survey is to appraise the probability that the project area contains prehistoric and historic properties. The definition of an historic property as used in this report, is any area altered by man that is likely to yield data important to the fields of archaeology, history or related disciplines.

The Phase I/Reconnaissance Survey was conducted according to the guidelines set by McManamon (1976) and the U.S. Army Corps of Engineers and involves:

--Examination of the National Register of Historic Places - 1976 and subsequent entries in the Federal Register to determine whether there are any National Register properties within the project area.

--Contacting the Massachusetts Historical Commission to determine if any as yet unregistered, but eligible sites meeting National Register criteria exist within the proposed project area.

--Checking the site files of the Massachusetts Historical Commission, the State Archaeologist and the Anthropology Department of the University of Massachusetts to determine whether there are any known prehistoric sites in the proposed project area.

--Researching state, county and local historical documents to determine the location of reported contact-period aboriginal sites, and of historic buildings and industrial sites within the proposed project area.

--Analysis of available geological, hydrological, ecological and soils data to determine the suitability of the environment for various types of historic and prehistoric sites as yet unreported within the proposed project area.

--Interviews with individuals knowledgeable in the history and prehistory of the project area. Such individuals include members of the Westfield Historical Commission and Society, librarians, artifact collectors and avocational and professional archaeologists. Regional museums and educational institutions were also contacted.

--Conducting short-term field work in order to determine present land-use in site-sensitive areas, the extent of modern disturbances and the existence of foundations and standing historic structures.

--Assessing the impact of the proposed project on identified or predicted archaeological properties.

--Making recommendations concerning intensive fieldwork (Phase II) in any sensitive areas that may have been identified.

The overall aim of the Phase I/Reconnaissance Survey is to delimit site-sensitive areas within the proposed project area that will require more intensive on-site inspection in the form of a Phase II Field investigation survey. A recommendation concerning further survey is included in the summary of the report.

PART ONE

WESTFIELD LOCAL FLOOD PROTECTION PROJECT

SETTING AND SCOPE

Project Description

The following description of the proposed Westfield Local Protection Project is broken down into thriteen survey units of approximately one-half mile each. These units are of manageable size and can be surveyed in one day. The survey units are listed and numbered from north to south, and from west to east; and the unit numbers indicate east and west boundaries that are recorded on the project maps (See Fig. 2). Thus, Powder Mill Brook, the northernmost water course in the project, is listed first and includes Survey Units 1-2 and 2-3. Survey Units along the Westfield River are 3-3 which run east to west along the northern bank, and on the south bank 5-6, 6-7,7-8, 8-9 and 9-10. Survey Units along the Little River are 11-12, 12-13, 13-14, 14-15, and 16-17.

Survey Unit 1-2. A proposed flood control dike extends from the intersection of Powder Mill Brook and North Elm Street to the bridge over the brook on Sandy Hill Road.

Survey Unit 2-3. A proposed flood control dike extends from the Sandy Hill Road bridge over Powder Mill Brook, east along the brook to the intersection of the brook and Union Street. The dike then bears south across Union Street and the Penn Central Railroad tracks and then west through an alfalfa field paralleling the tracks to Williams Riding Way.

Survey Unit 3-4. A proposed flood control dike extends west from Williams Riding Way north of Delancey Street, crossing Delancey Street approximately two hundred meters west, and then extends through two horse pastures and south of the Penn Central Railroad tracks to North Elm Street.

Survey Unit 5-6. A proposed flood control dike starts at a point in an agricultural field north of Stanley's produce stand on Route 20, that is at the westernmost tip of a large island. The dike extends east to the west boundary of Whitney Playground.

Survey Unit 6-7. A proposed flood control dike extends from the western boundary of Whitney Playground east along the Westfield River to the Elm Street bridge.

Survey Unit 7-8. A proposed flood control dike extends from the Elm Street bridge east along the river and then south at the river bend to a point in an agricultural field opposite and north of the Westfield wastewater treatment plant.

Survey Unit 8-9. A proposed flood control dike extends from the east bank of the Westfield River just southwest of the New England Concrete Pipe Company, east across the neck of land to the west bank of the river at the point where the river bends sharply to the east. A proposed overflow channel will carry flood waters across the neck.

Survey Units 9-10. A proposed flood control dike will extend from the west bank of the Westfield River just north of Delmont Avenue east to the Route 20 bridge over the river.

Survey Units 11-12. A proposed flood control dike will extend from the Stevens Paper Company dam just west of the intersection of Route 202 and the Little River, east along the river to a point due south of Riverside Drive in the area known locally as Squawfield.

Survey Unit 12-13. A proposed flood control dike will extend from a point due south of Riverside Drive, between a dirt power line access road and the Little River, east paralleling the river to the Penn Central Railroad bridge over South Meadow Road.

Survey Unit 13-14. A proposed dike will extend from the railroad bridge over South Meadow Road southeast to the Little River and then east paralleling the river to the point where the river bends north.

Survey Unit 14-15. A proposed dike and overflow channel will extend from the east bank of the Little River at the point where it bends northeast to the Westfield River. The survey unit ends at Little River Road. The dike will extend south across the overflow channel to the terrace south of the bowling alley in the Route 20 shopping center. The dike bears south and meets the glacial delta.

Survey Unit 16-17. A proposed dike will begin near Ridgecrest Drive and Little River Road and bear easterly for 100 meters. The dike will then veer north to the Route 20 bridge over the Westfield River. This survey unit includes a section of overflow channel from the Little River which ends at the Westfield River behind the Woronoco Savings Bank. The overflow channel crosses Little River Road and meets the river.

PART TWO

## RESEARCH DESIGN

The area to be affected by the proposed flood protection project was evaluated for the purpose of determining the location of historic and prehistoric properties that will be impacted by the project, and to assess the area's archaeological potential in terms of previously unknown resources.

### Prehistoric Site Potential

Studies of foraging populations in many areas of the world have indicated that such populations tend to adopt a least-effort strategy in the procurement of resources. That is, they tend to choose the most energy-efficient means of procuring the maximum resource yield, without sacrificing group well-being (Jochim 1976). One of many means of reducing energy expenditure is to minimize the distance between the place where the resource is available and the place where it is to be used. Therefore we may predict that sites that are located with resource-proximity in mind would be located in those areas that are most suitable for human comfort and are closest to the resource.

The major factors adversely affecting human physical comfort are (excluding lack of food) moisture and cold temperatures. Dry, level soils and the warmest available exposure would therefore be major criteria in the site selection process. We can logically predict that level areas with well-drained soils and slightly sloping areas that face the south would contain the highest site density.

In a riverine environment the most predictable and abundant resource is fish, and the easiest place to catch fish is at rapids or falls along major streams and rivers. Therefore areas that are dry and not subject to frequent flooding, but are near rapids or falls, on major streams and rivers, would have a high potential for aboriginal activity during much of the year, but particularly during anadromous fish runs during the spring. Some of southern New England's areas of highest site density, in terms of periodic reuse, are in such locations.

Perhaps the most critical resource to be considered, regardless of site function, is water, which is obviously already available at fishing locations. However, in inland situations where exploitative strategies shift to hunting of game and gathering of wild vegetable foods, sites are likely to be located near springs or near streams and lakes where limited amounts of

fish are also available.

Areas with natural resources known to have had technological importance among aboriginal populations are also likely places for prehistoric human activity. These resources include soapstone, quartzite, argillite, mud-stone, chert, jasper, volcanic diabase and rhyolite used in stone tool manufacture, and clays suitable for pottery making.

In order to stratify effectively the proposed project area, thereby eliminating low potential areas from consideration for cost-efficiency purposes, soils maps compiled by the Soils Conservation Service were consulted in order to delineate all areas with well-drained soils and minimal slopes. Level, well-drained soils in close proximity to water sources are considered to constitute areas of high potential. Those farther from a water source are considered to have lower potential. Rapids or falls are located by using aerial orthographic maps. Maps of bedrock and surficial geology and historical documents are useful in locating old fall lines that have been eroded by stream action and are no longer active. In addition to these sources, U.S.G.S. topographic maps were consulted to locate knolls, terraces and other points of high land in proximity to other important resources. Topographic maps were also used to determine which slopes have the warmest exposure. Usually areas with steep slopes (i.e., those over 15%), poorly drained soils, and/or northern aspects can be exempted from more intensive scrutiny and subjected only to a minimal "walk over."

Mineral outcrops are located through the use of geological maps and through historic sources. Many resources such as soapstone and clay also had economic importance in historic times, and are therefore recorded in economic geology and industrial reports.

This mode by no means presupposes that no sites ever exist in areas considered to have low potential. It is conceivable that occasionally human activity areas may be found on steep slopes or in poorly drained or swampy areas, but they are extremely rare, and while their rarity makes them interesting archaeologically, the prohibitive additional expense of using anything beyond minimal survey procedures to locate them cannot be justified.

## Historic Archaeological Properties

In order to locate and evaluate historic properties, the history of western Massachusetts, local histories and histories of bordering towns were researched for locational data and for information concerning the function of the various sites within

the project area. Survey maps of the town for the years 1795, 1831, 1855, 1870, 1891 and 1894 were also used to determine the location of recorded residential or industrial structures.

In some instances historic artifacts such as kaolin pipe stems, potsherds, coal, glass and buttons were located on the surface of cultivated fields, with no evidence of being associated with historic structures or features. In all of these cases, the artifact deposits were found within a few centimeters of the surface and were assumed to have been associated with nearby historic dumps. While artifacts such as these may suggest time periods of field use, they are not necessarily significant site indicators. Therefore no further survey is recommended when they are encountered.

## FIELD SURVEY METHODS

Prior to the actual field survey, local artifact collectors and individuals knowledgeable about local history and prehistory were consulted about the location of archaeological properties in the project area. In addition, the site files of the Massachusetts Archaeological Society (MAS) and the University of Massachusetts were consulted. All sites located in this manner were physically surveyed to verify their existence, measure their extent when possible and to determine their significance.

The entire project was subdivided into manageable survey units as described in Part I of this report. Three crews were formed, each including a supervisor and a field crew member. Whenever possible, one crew surveyed one-half of one survey unit.

The right-of-way of the proposed project was surveyed with soil-core transects, with visual reconnaissance conducted on both sides of the transect where necessary. Each transect involved the examination of soil profiles taken with a forty-centimeter soil-coring device at intervals ranging from ten to twenty meters depending of the terrain. In cases where large areas of artificial fill were evident, soil profiles were examined at fifty-meter intervals. Soil samples were collected generally at every other test station for subsequent phosphate "quick" tests in the lab. The assumption of the phosphate technique is that phenomena associated with human activities, such as waste or refuse deposition, cause increases in the phosphate contents of the soil, which are still detectable after thousands of years (See Eidt 1973). While the limitations of this method are acknowledged for the New England area, success has been achieved with it by some archaeologists working in the Connecticut Valley (e.g. Dincauze *et al.* 1976). Given the limitations of all conventional field methods available to this survey, and without having recourse to renting highly destructive and expensive auguring trucks or backhoes to reach below the deep alluvium, the minimal additional expense of the phosphate tests was justified. In two survey units, archaeological properties were located using this method.

Thirty-five to fifty-centimeter-square test pits were also excavated in each survey unit. One test pit was dug at the beginning (datum) of each transect and elsewhere at the discretion of the field supervisor. In determining the location of the pits, an effort was made to test all representative terrain of both high and low potential. Test pit locations were not chosen using a random numbers table because of the difficulty of finding the random locations in the dense brush in many of the survey units.

Back dirt from each test pit was screened through a forty-by-fifty centimeter screen with one-quarter-inch mesh. Soil profiles in each test pit were sketched on special forms and all artifacts were collected and catalogued. When cultural features such as hearths or midden were encountered, large samples of soil were collected for flotation analysis in the laboratory.

One-hundred-centimeter soil corers were used as a follow-up method for areas shown to have high potential by using other methods.

Systematic surface reconnaissance was conducted along all transects and in other selected areas in each survey unit. This was one of the most effective survey techniques used because of the number of exposed areas resulting from crop cultivation.

Finally, the locations of all sites, points of interest and survey unit boundaries were recorded using the Universal Transverse Mercator grid system.

### Historic Field Survey Techniques

Visual reconnaissance was conducted over the entire project area in order to verify the existence of reported sites and to locate others not recorded in historic documents. Field survey techniques used to locate prehistoric sites, such as soil coring and test pit excavation, were also used to gather data.

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PART THREE

ARCHAEOLOGICAL PROPERTIES INVENTORY

WESTFIELD LOCAL FLOOD PROTECTION PROJECT

The following is a detailed inventory of all archaeological properties within the proposed project area, listed by Survey Unit. Explicit locational data are purposely omitted from the inventory because of the potential damage to archaeological properties that may result in the form of vandalism, looting, "pot hunting," etc., should these data be made available to the wrong individuals.

Dates in this report are expressed as "years before present" or "B.P.", a term internationally used in archaeology and other disciplines dealing with the past. This standard was originally used in conjunction with radiocarbon dating, and is synonymous with "radiocarbon years." In order to avoid annual revision of published dates, "present" is 1950, and all B.P. dates mean "before 1950." Historic dates are expressed as years A.D.

SURVEY UNIT: 1-2

SITE NUMBER: Possibly MAS M29-92, W1

SITE TYPE: Prehistoric

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Massachusetts Archaeological Society records
Visual reconnaissance

CULTURAL MATERIAL OR EVIDENCE:

Prehistoric: 12 quartzite flakes
2 chert flakes
4 reddish-brown mudstone flakes

Historic: Ceramics, 1850's - 1890's
1 kaolinite pipe stem
White glass buttons
1 quahog shell

TIME OF OCCUPATION OR USE: Prehistorically, unknown
Historic material from 19th century

SITE SIZE: Not determined

ELEVATION: 37.5 meters; 2 meters above local water level

LANDFORM: Alluvial plain

WATER SOURCE: Powder Mill Brook

SOILS TYPE: Winooski silt loam - moderately shallow soils

DRAINAGE: Moderately well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 1-2

SITE NUMBER: W2

SITE TYPE: Historic dam, earthen

CONDITION OF SITE: Breached

SOURCE OF DATA: Visual reconnaissance; historic documents; Beers 1870: 16; Richards 1894: 53

CULTURAL MATERIAL OR EVIDENCE:

Remains of an earthen dam south of Powder Mill Brook

TIME OF OCCUPATION OR USE: 19th century

SITE SIZE: Approximately 30 meters in length

ELEVATION: 37.5 meters; 1.5 meters above local water level

LANDFORM: Alluvial plain.

WATER SOURCE: Powder Mill Brook

SOILS TYPE: Winooski silt loam - moderately shallow soils

DRAINAGE: Moderately well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 2-3

SITE NUMBER: W3

SITE TYPE: Historic sawmill

SOURCE OF DATA: Visual reconnaissance; historic documents;
Beers 1870: 16 and Richards 1894: 53

CULTURAL MATERIAL OR EVIDENCE:

Foundation of a possible sawmill recorded in Beers 1870 and Richards 1894

NOTE: Is associated with dam site in Survey Unit 1-2

TIME OF OCCUPATION OR USE: 19th century

SITE SIZE: Five by five meters

ELEVATION: 37.5 meters; 1.5 meters above local water level

LANDFORM: Alluvial plain

WATER SOURCE: Powder Mill Brook

SOILS TYPE: N/A

DRAINAGE: N/A

SLOPE & ASPECT: 3-8%

REMARKS: None

SURVEY UNIT: 2-3

SITE NUMBER: MAS M29-94, W4

SITE TYPE: Prehistoric

CONDITION OF SITE: Disturbed surface

SOURCE OF DATA: Massachusetts Archaeological Society, surface reconnaissance, soil coring

CULTURAL MATERIAL OR EVIDENCE:

Prehistoric: Possible base of a Levanna projectile point, 2 quartzite scrapers, 1 quartzite preform

Historic: Pottery, including blue transfer on creamware (1820's) light pearlware (1830's) and ironstone (1897-1904). Thousands of glass buttons. Roofing slate. Coal.

TIME OF OCCUPATION OR USE: Late Archaic and 19th century

SITE SIZE: Greater than 100 x 50 meters

ELEVATION: 36 meters; 1 meter above local water level

LANDFORM: Alluvial Plain

WATER SOURCE: Powder Mill Brook

DRAINAGE: Well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 2-3

SITE NUMBER: W5

SITE TYPE: Prehistoric

CONDITION OF SITE: Not disturbed on terrace

CULTURAL MATERIAL OR EVIDENCE:

Prehistoric: 1 ground stone effigy pestle, 25 x 3 cm.
1 ceramic bead, 2.5 x 2.5 cm, of unknown origin
1 quartzite biface
1 quartzite flake

Historic. Roofing slate, stoneware potsherd, whiteware pottery with brown rose pattern (late 19th-early 20th century) white porcelain (1790-1850) bottle necks of light blue glass with lipping tool marks (1850-1920) clear glass liquor bottle (1880-1920) quahog shell, coal & clinker

TIME OF OCCUPATION OR USE:

c. 3880 B.P. based on New York State data; 19th century

SITE SIZE: Not determined

ELEVATION: 67 meters WATER SOURCE: Powder Mill Brook

LANDFORM: GLACIAL TERRACE, PROBABLY DELTA

SOILS TYPE: Hinckley loam sand

DRAINAGE: Excessively drained SLOPE & ASPECT: 0-3%

REMARKS: Source of historic debris reputed to a nineteenth century boarding house located on the terrace and associated with Springdale mills.

A 20th century 410 gage shotgun shell also found

SURVEY UNIT: 2-3

SITE NUMBER: W6

SITE TYPE: Historic railroad station of the Boston and Albany Railroad

CONDITION OF SITE: DISTURBED

SOURCE OF DATA: Richards Atlas of Hampden County, 1894: 53.

CULTURAL MATERIAL OR EVIDENCE: Historic documents only

TIME OF OCCUPATION OR USE: Late 19th century

SITE SIZE: Not determined

ELEVATION: 40.5 meters

LANDFORM: Alluvial plain

WATER SOURCE: None

SOILS TYPE: Artificial fill over Handley very fine sandy loam

DRAINAGE: Well-drained

SLOPE & ASPECT: 0-3%

REMARKS: Unable to locate any remains of this structure

SURVEY UNIT: 2-3

SITE NUMBER: W7

SITE TYPE: Probably prehistoric

CONDITION OF SITE: Possibly undisturbed

SOURCE OF DATA: Test pits; 100-centimeter soil cores; phosphate tests

CULTURAL MATERIAL OR EVIDENCE: Black, greasy disturbances in soils at 46 cm., 93 cm., and 123 cm. in depth. Very high phosphate levels. No artifacts found.

TIME OF OCCUPATION OR USE: Unknown

SITE SIZE: Not determined

ELEVATION: 39 meters; 4 meters above local water level

LANDFORM: Knoll or alluvial plain.

WATER SOURCE: Westfield River; also close to Powder Mill Brook

SOILS TYPE: Hadley very fine sandy loam

DRAINAGE: Well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 3-4

SITE NUMBER: W8

SITE TYPE: Historic bridge abutment

CONDITION OF SITE: Disturbed (because of dam and new bridge construction)

SOURCE OF DATA: Janes and Scott 1969; 191

CULTURAL MATERIAL OR EVIDENCE: None

TIME OF OCCUPATION OR USE: Prior to 1840

SITE SIZE: Not determined

ELEVATION: 36 meters

ELEVATION ABOVE WATER: 2-3 meters

LANDFORM: Alluvial plain

SOILS TYPE: Unknown alluvial soils. Shown as "made land" on Soils Conservation Service Soils map

DRAINAGE: Unknown

SLOPE & ASPECT: 0-3%

REMARKS: No remains of the bridge were located

SURVEY UNIT: 3-4

SITE NUMBER: W9

SITE TYPE: Historic saw and grist mill; and powder mill

CONDITION OF SITE: Probably destroyed

SOURCE OF DATA: Beers' Atlas 1870:16; Flahive 1969:349; Walling 1855

CULTURAL MATERIAL OR EVIDENCE: Evidence is only documentary. Beers' Atlas shows several buildings of the Rockwell-Mosely Company, south of the present Penn Central tracks, all in the vicinity of the coal shed W10. The complex included a saw and grist mill originally owned by Chauncey Atkins (n.d.) and a powder mill (Flahive 1969:349), operated by Rockwell and Mosely. Walling (1855) shows a large sawmill owned by the Yeamans near the present highway bridge.

TIME OF OCCUPATION OR USE: 19th century

SITE SIZE: 100 x 200 meters approximate area

ELEVATION: 39 meters

ELEVATION ABOVE WATER: 4 meters

LANDFORM: Alluvium plain

WATER SOURCE: Westfield River

SOILS TYPE: Unknown--shown as "made land" on Soils Conservation Service soils map

DRAINAGE: Unknown

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 3-4

SITE NUMBER: W10

SITE TYPE: Historic coal shed and railroad span

CONDITION OF SITE: Still standing, but portions are collapsing

SOURCE OF DATA: Richards 1894:5. Visual reconnaissance

CULTURAL MATERIAL OR EVIDENCE:

Large three story wooden structure. Old coal bins still have coal in them. Remains of an old railroad spur are visible east of the shed running east to meet the main tracks, approximately 100 meters.

TIME OF OCCUPATION OR USE: Late 19th and 20th centuries

SITE SIZE: Approximtely 30 meters long, 15 meters wide

ELEVATION: 39 meters

ELEVATION ABOVE WATER: 4 meters

LANDFORM: Alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Unknown--shown as "made land" on Soils Conservation Service soils map

DRAINAGE: Unknown

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 3-4

SITE NUMBER: W11

SITE TYPE: Historic box factory

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Richards 1894:53. Visual reconnaissance

CULTURAL MATERIAL OR EVIDENCE:

Large rectangular blocks of granite, 1 x 2 meters in size, with steel machine support bolts on top

TIME OF OCCUPATION OR USE: Late 19th century

SITE SIZE: Observed approximately 5 x 5 meters

ELEVATION: 36 meters

ELEVATION ABOVE WATER: 2-3 meters

LANDFORM: Alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Unknown--shown as "made land" on Soils Conservation Service soils map.

DRAINAGE: Unknown

SLOPE & ASPECT: 0-3%

REMARKS: Severely damaged and subject to flooding

SURVEY UNIT: 3-4

SITE NUMBER: W12

SITE TYPE: Historic/prehistoric

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Test Pit

CULTURAL MATERIAL OR EVIDENCE:

1 basalt flake found at 26 centimeters in depth
Shell fragment (quahog)
Charcoal lens at 49 centimeters in depth
Black, greasy disturbance at 75 centimeters in depth

TIME OF OCCUPATION OR USE: Unknown

SITE SIZE: Not determined

ELEVATION: 36 meters

ELEVATION ABOVE WATER: 3 meters

LANDFORM: Alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Unknown--shown as "made land" on Soils Conservation Service soils map; is probably Winooski silt loam.

DRAINAGE: Moderately well-drained

SLOPE & ASPECT: 0-3%

REMARKS: Owner said that the southern portion of the field was scoured out in the 1955 flood, but no evidence of that was noticed. The basalt flake may be associated with the railroad which is approximately 150 meters to the North. This site is near the Guida Farm Site (Byers & Rouse 1960).

SURVEY UNIT: 3-4

SITE NUMBER: W13

SITE TYPE: Prehistoric

CONDITION OF SITE: Probably disturbed

SOURCE OF DATA: 100-cm. soil cores. Phosphate tests. Visual reconnaissance

CULTURAL MATERIAL OR EVIDENCE:

1 chert flake in road
Dark, greasy diturbances in soil profiles
Moderately high phosphate levels

TIME OF OCCUPATION OR USE: Unknown

SITE SIZE: Not determined

ELEVATION: 39 meters

ELEVATION ABOVE WATER: 4 meters

LANDFORM: Alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Unknown--shown as "made land" on Soils Conservation Service soils map, but is probably part of the Winooski silt loam that abuts the field on the east.

DRAINAGE: Moderately well-drained

SLOPE & ASPECT: 0-3%

SURVEY UNIT: 5-6 and 6-7

SITE NUMBER: W14

SITE TYPE: Historic dike

CONDITION OF SITE: Functional. Currently maintained

SOURCE OF DATA: Richards 1894:53

CULTURAL MATERIAL OR EVIDENCE:

Flood control dike approximately 5 meters high

TIME OF OCCUPATION OR USE: Late 19th century to present

SITE SIZE: Approximately 400 meters long

ELEVATION: 42 meters

ELEVATION ABOVE WATER: 5-9 meters

LANDFORM: Alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Suncook loamy fine sand and Podunk fine sandy loam

DRAINAGE: Excessively well & moderately well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 5-6

SITE NUMBER: W15

SITE TYPE: Historic/prehistoric

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Visual reconnaissance

CULTURAL MATERIAL OR EVIDENCE:

Fire-cracked rock on surface
Fragments of light pearlware with dark blue willow pattern transfer printed, 1810-1850
1 possible flake - quartzite

TIME OF OCCUPATION OR USE: Unknown prehistorically; historically, 19th century

SITE SIZE: Not determined

ELEVATION: 39 meters

LANDFORM: Alluvial plain

SOILS TYPE: Suncook loamy fine sand

DRAINAGE: Excessively drained

SLOPE & ASPECT: 0-8%

REMARKS: None

SURVEY UNIT: 6-7

SITE NUMBER: W16

SITE TYPE: Historic blacksmith shop

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Richards 1894:53

CULTURAL MATERIAL OR EVIDENCE: Documentary only (Richards 1894:53)

TIME OF OCCUPATION OR USE: Late 19th century

SITE SIZE: Unknown

ELEVATION: 42 meters

ELEVATION ABOVE WATER: 4 meters

LANDFORM: High alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Unknown. Shown as "made land" on Soils Conservation Service soils map

DRAINAGE: Unknown

SLOPE & ASPECT: Level

REMARKS: Unable to find original structure

SURVEY UNIT: 6-7

SITE NUMBER: W17

SITE TYPE: Historic ice house

CONDITION OF SITE: Disturbed

CULTURAL MATERIAL OR EVIDENCE: Documentary only

TIME OF OCCUPATION OR USE: Late 19th century

SITE SIZE: Unknown

ELEVATION: 42 meters

ELEVATION ABOVE WATER: 4 meters

LANDFORM: High alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Unknown. Shown as "made land" on Soils Conservation Service soils map

DRAINAGE: Unknown

SLOPE & ASPECT: Level

REMARKS: Unable to locate original structure

SURVEY UNIT: 6-7

SITE NUMBER: W18

SITE TYPE: Historic gas company

CONDITION OF SITE: Unknown

SOURCE OF DATA: Beers 1870:16; Richards 1894:53

CULTURAL MATERIAL OR EVIDENCE: Documentary only

TIME OF OCCUPATION OR USE: Late 19th century

SITE SIZE: Unknown

ELEVATION: 42 meters

ELEVATION ABOVE WATER: 4 meters

LANDFORM: High alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Unknown. Shown as "made land" on Soils Conservation Service soils map

DRAINAGE: Unknown

SLOPE & ASPECT: Level

REMARKS: Original structure possibly incorporated into recent structures

SURVEY UNIT: 7-8

SITE NUMBER: W19

SITE TYPE: Prehistoric

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Visual reconnaissance. Collector

CULTURAL MATERIAL OR EVIDENCE:

1 quartzite flake
3 chert flakes

TIME OF OCCUPATION OR USE: Unknown

SITE SIZE: Unknown

ELEVATION: 39 meters

ELEVATION ABOVE WATER: 3-4 meters

LANDFORM: Alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Winooski silt loam

DRAINAGE: Moderately well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 9-10

SITE NUMBER: W20

SITE TYPE: Prehistoric

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Randy Moir, Westfield, MA Visual reconnaissance

CULTURAL MATERIAL OR EVIDENCE:

18 quartzite flakes
18 chert flakes
Charcoal lens 27 centimeters below present surface

TIME OF OCCUPATION OR USE: Unknown

SITE SIZE: 10 x 10 meters

ELEVATION: 36 meters

ELEVATION ABOVE WATER: 3 meters

LANDFORM: Alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Hadley very fine sandy loam

DRAINAGE: Well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 9-10

SITE NUMBER: W21

SITE TYPE: Prehistoric - multi-component site

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Visual reconnaissance. Massachusetts Archaeological Society records

CULTURAL MATERIAL OR EVIDENCE:

31 chert flakes
1 projectile point tip
28 quartzite flakes
1 pecked ground stone tool - Mt. Holyoke diabase blue glaze pottery, popular in the 1820's
1 kaolinite pipe stem

TIME OF OCCUPATION OR USE: Prehistorically unknown (possibly 3000 B.P. and later). Also 19th century

SITE SIZE: At least 600 x 50 meters

ELEVATION: 36 meters

ELEVATION ABOVE WATER: 3 meters

LANDFORM: Alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Hadley very fine sandy loam

DRAINAGE: Well-drained

SLOPE & ASPECT: 0-3%

REMARKS: This site has at least three artifact clusters with artifact scatter throughout. The site may continue southward as part of those in Survey unit 16-17.

SURVEY UNIT: 11-12

SITE NUMBER: W22

SITE TYPE: Historic dump

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Visual reconnaissance

CULTURAL MATERIAL OR EVIDENCE:

Pink-lustered glass popular during the late 19th, early 20th centuries
Historic debris

TIME OF OCCUPATION OR USE: 20th century, possibly late 19th

SITE SIZE: Unknown

ELEVATION: 45 meters

ELEVATION ABOVE WATER: 5 meters

LANDFORM: Alluvial plain

WATER SOURCE: Little River

SOILS TYPE: Ondawa fine sandy loam

DRAINAGE: Well-drained to somewhat excessively well-drained

SLOPE & ASPECT: 0-3%

REMARKS: Reported to be a town dump over 40 years old. This was not verified

SURVEY UNIT: 11-12

SITE NUMBER: W23

SITE TYPE: Historic paper mill and powder mill

CONDITION OF SITE: Function

SOURCE OF DATA: Beers [illegible] Richards 1894

CULTURAL MATERIAL OR EVIDENCE:

Standing structure, presently being used as Stevens Paper Company Mill.
Includes an old railroad spur to the north-south tracks now used by the Penn Central Railroad. The tracks were in use until 10-15 years ago (Lester Eldridge, personal communication).
Also includes a coal loading platform

TIME OF OCCUPATION OR USE: Mid-19th century to present

SITE SIZE: 100 x 100 meters

ELEVATION: 45 meters

ELEVATION ABOVE WATER: 5 meters

LANDFORM: Alluvial plain

WATER SOURCE: Little River

SOILS TYPE: Ondawa fine sandy loam

DRAINAGE: Well-drained to somewhat excessively well-drained

SLOPE & ASPECT: 0-3%

REMARKS: This is one of the earliest mill sites in Westfield, granted on March 24, 1702 (Flahive 1969:345) and was the site of a powder mill, operated by a Col. Foote. The powder mill exploded in 1834 (Flahive 1969:349).

SURVEY UNIT: 12-13

SITE NUMBER: W24

SITE TYPE: Historic dam, possibly recent--and old feeder canal

CONDITION OF SITE: Breached--possibly gone

SOURCE OF DATA: U.S. Army Corps of Engineers map;
Mr. Pfunder, Westfield MA

CULTURAL MATERIAL OR EVIDENCE: Documentary only. 1831 survey map shows dam and feeder canal of the Hampden Canal System at this location.

TIME OF OCCUPATION OR USE: Unknown

SITE SIZE: Approximately 30 meters

ELEVATION: 42 meters

ELEVATION ABOVE WATER: 4 meters

LANDFORM: Alluvial plain

WATER SOURCE: Little River

SOILS TYPE: N/A

DRAINAGE: N/A

SLOPE & ASPECT: N/A

REMARKS: Structural remains were not found. Dam may have been destroyed by the 1955 flood.

SURVEY UNIT: 12-13

SITE NUMBER: Possibly MAS M28-11, W25

SITE TYPE: Prehistoric

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Massachusetts Archaeological Society records

CULTURAL MATERIAL OR EVIDENCE:

4 quartzite flakes
1 chert projectile point tip
1 small fragment of shell

TIME OF OCCUPATION OR USE: Unknown

SITE SIZE: Unknown

ELEVATION: 43.5 meters

ELEVATION ABOVE WATER: 3 meters

LANDFORM: Alluvial plain

WATER SOURCE: Little River

SOILS TYPE: Podunk fine sandy loam

DRAINAGE: Moderately well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 13-14

SITE NUMBER: W16

SITE TYPE: Possibly prehistoric

CONDITION OF SITE: Disturbed

SOURCE OF DATA: 100-cm. soil cores. Phosphate tests

CULTURAL MATERIAL OR EVIDENCE:

4 distinct brownish-black bands at 40 cm., 60 cm., 83 cm. and 94 cm.

TIME OF OCCUPATION OR USE: Unknown

SITE SIZE: Unknown

ELEVATION: 41 meters

ELEVATION ABOVE WATER: 3-4 meters

LANDFORM: Alluvial plain

WATER SOURCE: Little River

SOILS TYPE: Hadley very fine sandy loam

DRAINAGE: Well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 13-14

SITE NUMBER: W27

SITE TYPE: Prehistoric/historic

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Surface reconnaissance

CULTURAL MATERIAL OR EVIDENCE:

1 quartzite flake
1 melted piece of copper
1 kaolinite pipe bowl

TIME OF OCCUPATION OR USE: Unknown

SITE SIZE: Unknown

ELEVATION: 40.5 meters

ELEVATION ABOVE WATER: 3 meters

LANDFORM: Alluvial plain

WATER SOURCE: Little River

SOILS TYPE: Hadley very fine sandy loam

DRAINAGE: Well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

SURVEY UNIT: 13-14

SITE NUMBER: W28

SITE TYPE: Prehistoric

CONDITION OF SITE: Disturbed

CULTURAL MATERIAL OR EVIDENCE:

1 Susquehanna broad projectile point
2 perforators (chert)
1 ground stone adze
1 ground stone gouge

TIME OF OCCUPATION OR USE: Approximately 3000 B.P. Late Archaic

SITE SIZE: Not determined

ELEVATION: 40.5 meters

ELEVATION ABOVE WATER: 1 meter

LANDFORM: Alluvial plain

WATER SOURCE: Little River

SOILS TYPE: Ondawa fine sandy loam. High bottom

DRAINAGE: Well-drained

SLOPE & ASPECT: 0-3%

REMARKS: Unable to survey adequately

SURVEY UNIT: 13-14

SITE NUMBER: W29

SITE TYPE: Historic canal

CONDITION OF SITE: Good

SOURCE OF DATA: Plan of the town of Westfield 1831; U.S.G.S. topographic maps. Visual reconnaissance

CULTURAL MATERIAL OR EVIDENCE:

Stone abutment for aqueduct that carried the canal across the Little River
Towpath and canal trench extending from the Little River 1000 meters east to Little River Road

TIME OF OCCUPATION OR USE: 1829-1848

SITE SIZE: 1000 meters long, 10-15 meters wide

ELEVATION: 42 meters

ELEVATION ABOVE WATER: Approximately 10 meters

LANDFORM: At foot of glacial delta

WATER SOURCE: Westfield River

SOILS TYPE: Hinckley loamy sand

DRAINAGE: Well-drained

SLOPE & ASPECT: 15-25%

REMARKS: The canal and towpath are in very good condition and are undoubtedly of National Register quality. Ms. Cass Mason of the Department of Anthropology at the University of Massachusetts is in the process of nominating the site to National Register status (Cass Mason, personal communication).

SURVEY UNIT: 16-17

SITE NUMBER: W30

SITE TYPE: Prehistoric multi-component site

CONDITION OF SITE: Disturbed

SOURCE OF DATA: Visual reconnaissance. Phosphate tests

CULTURAL MATERIAL OR EVIDENCE:

Narrow stemmed quartzite projectile point
Scraper made of European flint
20 chert flakes
10 quartzite flakes
2 kaolinite pipe stems

TIME OF OCCUPATION OR USE: Approximately 3000 B.P., historic contact period

SITE SIZE: Approximately 200 x 200 meters

ELEVATION: 36 meters

ELEVATION ABOVE WATER: 4 meters

LANDFORM: Alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Winooski silt loam

DRAINAGE: Moderately well to well-drained

SLOPE & ASPECT: 0-3%

REMARKS: This site probably extends all the way to the Westfield River

SURVEY UNIT: 16-17

SITE NUMBER: W31

SITE TYPE: Prehistoric multi-component site.

CONDITION OF SITE: Damaged

SOURCE OF DATA:

CULTURAL MATERIAL OR EVIDENCE:

1 Neville projectile point
1 Squibnocket triangular projectile point
5 narrow stemmed projectile points
1 ground stone basalt axe
1 ground stone tool

TIME OF OCCUPATION OR USE: At least Middle and Late Archaic. 6000 B.P. and later

SITE SIZE: Unknown

ELEVATION: 36 meters

ELEVATION ABOVE WATER: 4 meters

LANDFORM: Alluvial plain

WATER SOURCE: Westfield River

SOILS TYPE: Winooski silt loam

DRAINAGE: Moderately well to well-drained

SLOPE & ASPECT: 0-3%

REMARKS: None

## IDENTIFICATION OF PROJECT IMPACTS

The goal of this archaeological survey is to identify known historic and prehistoric archaeological properties that are to be impacted adversely either directly or indirectly by the proposed flood control project and to assess the sensitivity of the areas in terms of previously unknown sites, so that destruction of those resources may be avoided or mitigated. Direct impact will occur if the proposed project passes through or near a cultural resource, resulting in physical destruction of the resource or in disrupting the historical integrity of the resource (Dincauze *et al*. 1976:41). Direct impact may occur as the result of the actual project construction or from borrow pit operations incidental to the project. Indirect impact can occur when potential areas for development are created as a result of zoning changes following dike construction. This is particularly important in areas that were previously unsuitable for construction because of their classification as flood plain. Development of this type can result in the destruction of archaeological properties outside of the proposed project area, as structures such as houses, outbuildings and wells are constructed.

EVALUATION OF PROJECT IMPACTS

WITH RECOMMENDATIONS FOR FURTHER SURVEY

The following is a discussion of the project's impacts (both direct and indirect) on historic and prehistoric archaeological properties. Each site discussed is described in detail in the section entitled Archaeological Properties in the Westfield Local Flood Protection Project Area.

The text that follows is to be used as an addendum to the previously conducted Phase I Survey for reported sites (Barber 1976).

Survey Unit 1-2

There should be no direct impact to Site W1. The site is south of the project and dike construction should channel flood waters away from the site. The historic dam (Site W2) may be impacted directly by the dike. Preliminary project maps are unclear as to how close the dike will come to Powder Mill Brook. If it is to pass close to the stream bank, the southern portion of the dam will be impacted. Flood waters that presently pass around the dam will be contained by the dike and damage to the dam will occur. In order to facilitate water flow in the event of a flood, it may be advisable at the time of dike construction to remove the dam entirely. In any event, direct impact to the dam with adverse effect is likely to occur. It is recommended that the dam and the associated sawmill (See Survey Unit 2-3) be evaluated by an industrial archaeologist to determine the significance of the site and its value to archaeology. Survey time is included under Survey unit 2-3, below.

Survey Unit 2-3

Direct impact is likely to occur to the site of a nineteenth century sawmill (Site W3). Portions of the foundation are in the vicinity of the south part of the proposed dike. It was unclear from the survey how much of the site may exist between the foundation and the stream bank. It is recommended that the sawmill and the associated dam (See Survey Unit 1-2) be intensively surveyed by an industrial archaeologist to determine the significance of the site and its value to archaeology. This should take an archaeologist, an assistant, and two crew members two days, which may include archival research and/or examination of town records. With the exception of the inclusion of the mill in Richards (1894) and Beers (1870), no mention is made of the industry in the historic documents researched during this survey.

Direct impact will occur in the vicinity of Site W4 (MAS #M29-94). According to preliminary maps, the dike will pass directly over the site. The significance of this site cannot be assessed without further survey. It is recommended that a prehistoric archaeologist intensively survey the site in order to evaluate the amount of disturbance that has taken place, the present integrity of the site, and the significance of the site to prehistoric archaeology. This should take an archaeologist, an assistant and two crew members two days.

Direct impact is expected to occur on the prehistoric site (W5). The proposed dike will channel flood waters toward the terrace and will result in bank erosion, possibly leading to the destruction of portions of the site. It is suspected that the main part of the site is located on top of the terrace. Much of the terrace has already been removed during sand pit operations. It is recommended that an archaeologist intensively survey the site to determine its condition and significance. This should take a four person crew one day.

Direct impact may occur in the vicinity of the nineteenth century Springdale Railroad Station (Site W6). No remains of the structure were located during the Phase I survey, and it is suspected that track widening operations through the area may have obliterated any remains of the structure. It is recommended that the vicinity be checked by an historic archaeologist to determine whether or not archaeological remains exist at all. This should take a four person crew one day.

Direct impact may occur to prehistoric cultural properties in Site W7. No artifacts were found in this area, but midden-like disturbances deep below the surface, coupled with very high phosphate levels, indicate the possibility of a site at this location. It is recommended that a prehistoric archaeologist evaluate the field, particularly in the area of a small knoll halfway between Williams Riding Way and the railroad tracks, to determine whether or not a site exists and, if so, to determine its significance. This should take four people two days.

Survey Unit 3-4

No impact is expected to occur in the vicinity of the nineteenth century bridge (Site W8) over the Westfield River. Construction of the present bridge and construction of a dam across the river at that point have destroyed any remains that may have existed. In addition, the proposed construction of the concrete wall in its vicinity will take place north of the old bridge. No further survey is recommended.

Direct impact may occur to the south portion of a nineteenth century saw and grist mill (Site W9). There is a large coal shed (Site W10) which may be impacted by the proposed dike. It is recommended that an industrial archaeologist intensively survey the area to determine the significance of the sites. This should take the archaeologist, an assistant, and two crew members one day.

Direct impact is likely to occur in the vicinity of the box factory (Site W11) north of the Westfield River. This site has been extensively disturbed, but the extent of the disturbance below the ground was not evaluated during the survey. It is recommended that the area be intensively surveyed by an industrial archaeologist. This should take an archaeologist, an assistant and two crew members one day.

Direct impact will occur to the possible prehistoric site (Site W12). No diagnostic prehistoric artifacts were recovered at this location, but a charcoal lens and midden-like disturbance were found deep below the surface. This is a high potential area. (Byers & Rouse 1960). It is recommended that the area be surveyed by an archaeologist specializing in New England prehistory. This should take a four person crew two days. The property to the east of Site W12 may be a part of it. Permission to survey was denied and a survey should be done during the Phase II intensive survey. This should take a four person crew one day. If a site is found, additional time will be necessary to evaluate it.

Direct impact will occur to the possible prehistoric property (Site W13).

Dark, greasy disturbances were observed in the soil profiles and a chert flake was found in the road approximately thirty meters from the center of the field. This area also has a high potential. The owner of the property said that she remembered burials being found here some years ago. It is recommended that the field be intensively surveyed by a prehistoric archaeologist. This should take a four person crew one day.

Survey Unit 5-6

Impact to the nineteenth century flood control dike will be discussed under Survey Unit 6-7 below.

Direct impact may occur in the vicinity of a possible historic/prehistoric site (Site W15). It is recommended that the site be surveyed by a prehistoric archaeologist to determine its significance and extent. This survey should be done during the late fall or early spring after harvest or before planting. This

should take one day.

The eastern portion of this survey unit was also inadequately surveyed because of dense shrubby vegetation including briers, vines and poison ivy. The area has a high potential based on soils conditions and its proximity to "Half Mile" falls on the Westfield River. The area to be further surveyed should include the large island located at the north terminus of Beckwith Avenue. Further survey at the Phase II level will take four people two days if a backhoe or other earth-moving equipment is employed. Because of the depth of alluvium, more time will be required if no mechanized equipment is available.

Survey Unit 6-7

Direct impact will occur on the old town dike (Site W14) at one point in this area. The proposed flood control dike will meet the old dike near its intersection with Sackett Street. No adverse effect is expected, and no further survey is necessary. South of the old dike are the remains of an 1894 blacksmith shop, an 1870 ice house and the nineteenth century Westfield Gas Light Company (Sites W16, W17, and W18 respectively). All of these are south of the project area and none will be impacted directly. Because they are presently being used by the Westfield Gas & Electric Company, it is unlikely that the proposed dike will have any adverse effect on these properties. No further survey is recommended. It was evident that any prehistoric archaeological properties that may exist in this survey unit would have been destroyed by stream action and/or the construction of Whitney Playground, which involved considerable earth-moving activities. No further survey is recommended.

Survey Unit 7-8

Direct impact is likely to occur to prehistoric Site W19. The extent and nature of the site are not known. Only a surface collection was conducted. It is recommended that the site be surveyed by an archaeologist specializing in New England prehistory. This should take four people one day.

Survey Unit 9-10

Direct impact will occur to the prehistoric Site W20. It is recommended that the site be surveyed by a prehistoric archaeologist with access to earth-moving equipment due to the extensive deposits of alluvium. This should take four people one day. Because of dense vegetation at the time of this survey, between Sites W20 and W21, this area was not surveyed adequately. The area has a high potential because of its soils and slope

conditions, its proximity to rapids, its location between two known sites and its undisturbed nature. It is recommended that the area be surveyed by a prehistoric archaeologist and that earth-moving equipment be employed because of the deep alluvium. This should take four people one day.

Direct impact will occur to Site W21, over practically its entire length. This site is believed to contain many occupations and is undoubtedly several sites. The area has been cultivated heavily, but because of the depth of alluvium, sites may be preserved. It is recommended that the site or sites be intensively surveyed by an archaeologist specializing in New England prehistory, and that earth-moving equipment be employed wherever it is deemed necessary by the archaeologist. This should take four people two days.

Survey Unit 11-12

Direct impact to a large dump, used until a few years ago, will occur in this area. Because of its disturbed nature, no further survey is recommended.

No direct impact is expected to occur to the Stevens Paper Company Mill (W23), formerly the Crane Brothers Japanese Mill, or to the dam associated with that establishment. No further survey is necessary. The old railroad spur from the mill to the present Penn Central tracks will be impacted directly along almost its entire length. The line has been completely removed within the last fifteen years and has been replaced by a road. Any remains of the spur are unlikely to be of archaeological value, because they were maintained until recently. The coal loading platform also associated with the Crane Brothers Mill has been razed and bulldozed over the bank into the Little River. No further survey is recommended.

Survey Unit 12-13

No impact, direct or indirect, should occur to the remains of the dam south of the Strathmore Paper Company (Site W24). The proposed dike itself will be north of this location and floodwaters are already being channelled through the site by a spoil dike constructed by the U.S. Army Corps of Engineers in 1955. No further survey is recommended.

Direct impact is expected to occur in the vicinity of the prehistoric Site W25. This site is possibly MAS Site #M29-11. It is recommended that this area be surveyed by an archaeologist specializing in New England prehistory in order to determine how much disturbance has taken place there, the extent of the site

(which may extend over 100 meters to the east) and to determine the significance of the site. This should take four people two days.

Survey Unit 13-14

Several dark, midden-like soil bands associated with high phosphate levels were encountered at Site W26. Although no artifacts were found, other indications suggest that a site exists at this location. The site is in the path of the projected dike and direct impact will occur. It is recommended that a prehistoric archaeologist survey the area in order to determine whether or not the site exists and to evaluate its significance. This should take four people two days.

Direct impact will occur at another possible prehistoric site (Site W27). It is recommended that this site be evaluated by a prehistoric archaeologist. This should take one day.

Direct impact in the form of inundation by rechannelled flood waters may occur in the area of a possible prehistoric site (Site W28).

Construction of the dike may channel floodwaters to the south side of the river. This site was reported by a local collector. Although a partial visual reconnaissance was conducted here, only historic debris associated with the railroad was found. It is recommended that the area be intensively surveyed during either the early spring or late fall. Any sites found need to be evaluated. This should take four people one day.

Survey Unit 14-15

The construction of the proposed Little River overflow channel will directly impact the stone aqueduct support on the east bank of the Little River, and to the eastern portions of the Hampden Canal trench (Site M29). The canal and towpath are in good condition from the Little River to Little River Road. It is recommended that damage to this section be avoided if at all possible. This site has been thoroughly researched by Ms. Cass Mason of the University of Massachusetts and is presently being nominated for National Register status.

There should be no impact with adverse effect in the western portion of the canal because the proposed overflow channel passes well to the south of it.

Survey Unit 16-17

Direct impact will occur to the prehistoric Site W30. The proposed dike passes directly through this site, and possibly the most destructive impact is already occurring in the form of continual erosion by the Westfield River. This will ultimately result in the destruction of their cultural property. If the proposed dike were moved east to follow the course of the river, this ongoing destruction may be averted. This probably would not eliminate direct impact by the dike because the site may extend all the way to the river. Impact of an indirect nature may also occur if the dike were moved, if the land then protected by the dike were made attractive for development as a result. In any case, further survey of this area is highly recommended. This site contains at least two components, possibly representing some 3000 years of occupation. That survey should take place in early spring or late fall, and should take four people two days.

Direct impact is also likely on a prehistoric site well known to local collectors (Site W31), and includes artifacts known to have been used 6000 years ago, a time not well documented in New England prehistory. It is recommended that an archaeologist specializing in New England prehistory intensively survey this site in order to evaluate the damage that has taken place there, the significance of the site, and its relationship to sites W20 and W21 (Survey unit 9-10). This should take four people two days.

## SUMMARY OF FURTHER SURVEY RECOMMENDATIONS

In summary, a Phase II intensive field survey is recommended for the proposed Westfield Local Flood Protection Project. Twenty-one sites, two overgrown areas and one area of refused access should be intensively surveyed by qualified archaeological personnel in order to clarify and evaluate the nature of the archaeological properties to be impacted, and to determine whether or not mitigation is necessary. The following is a table of further field survey recommended, listed by Survey Units. In all cases, a four person crew, consisting of an archaeologist, assistant and two crew members, is assumed.

| Survey Unit/Site | Recommended Historic/Industrial Survey Days | Recommended Prehistoric Survey Days | Total |
|---|---|---|---|
| 1-2/W2 and 2-3/W3 | 2 | - | 2 |
| 2-3/W4 | - | 2 | 2 |
| 2-3/W5 | - | 1 | 1 |
| 2-3/W6 | 1 | - | 1 |
| 2-3/W7 | - | 2 | 2 |
| 3-4/W9 and W10 | 1 | - | 1 |
| 3-4/W11 | 1 | - | 1 |
| 3-4/W12 | - | 2 | 2 |
| 3-4/Denied access area | - | 1 | 1 |
| 3-4/W13 | - | 1 | 1 |
| 5-6/W15 | - | 1 | 1 |
| 5-6/Overgrown area | - | 2 | 2 |
| 7-8/W19 | - | 1 | 1 |
| 9-10/W20 | - | 1 | 1 |
| 9-10/Overgrown area | - | 1 | 1 |
| 9-10/W21 | - | 2 | 2 |
| 12-13/W25 | - | 2 | 2 |
| 13-14/W26 | - | 2 | 2 |
| 13-14/W27 | - | 1 | 1 |
| 13-14/W28 | - | 1 | 1 |
| 13-14/W29 | - | 1 | 1 |
| 13-14/W30 | - | 2 | 2 |
| 13-14/W31 | - | 2 | 2 |
| TOTALS | 5 | 28 | 33 |

At least two person days per site will be needed for laboratory work and at least one day per site will be needed to write the report. Additional funds will be needed for report preparation, direct expenses and overhead.

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APPENDIX I

SOILS--WESTFIELD LOCAL FLOOD PROTECTION PROJECT

| Map Symbol | Soil Map Legend | Slope | Drainage | Site Potential |
|---|---|---|---|---|
| 51-A | Made land | - | - | None |
| 310-D | Hinckley loamy sand | - | Excessive | High |
| 311-F | Merrimac fine sandy loam | 0-3% | Good | High |
| 420-B-DE | Windsor loamy sand | 15-35% | Excessive | High |
| 501-B-A | Suncook loamy fine sand | 0-3% | Excessive | High |
| 501-B-B | Suncook loamy fine sand | 3-8% | Excessive | High |
| 501-V-A | Hadley very fine sandy loam, high bottom | 0-3% | Good | High |
| 501-V-B | Hadley very fine sandy loam, high bottom | 3-8% | Good | High |
| 502-N-A | Winooski silt loam | 0-3% | Moderate | Moderate |
| 512-F-A | Podunk fine sandy loam | 0-3% | Moderate | Moderate |
| 553-N-A | Limerick silt loam | 0-3% | Poor | Low |
| 554-N-A | Saco silt loam | 0-3% | Poor | Low |
| 561-F-A | Ondawa fine sandy loam, high bottom | 0-3% | Excessive | High |

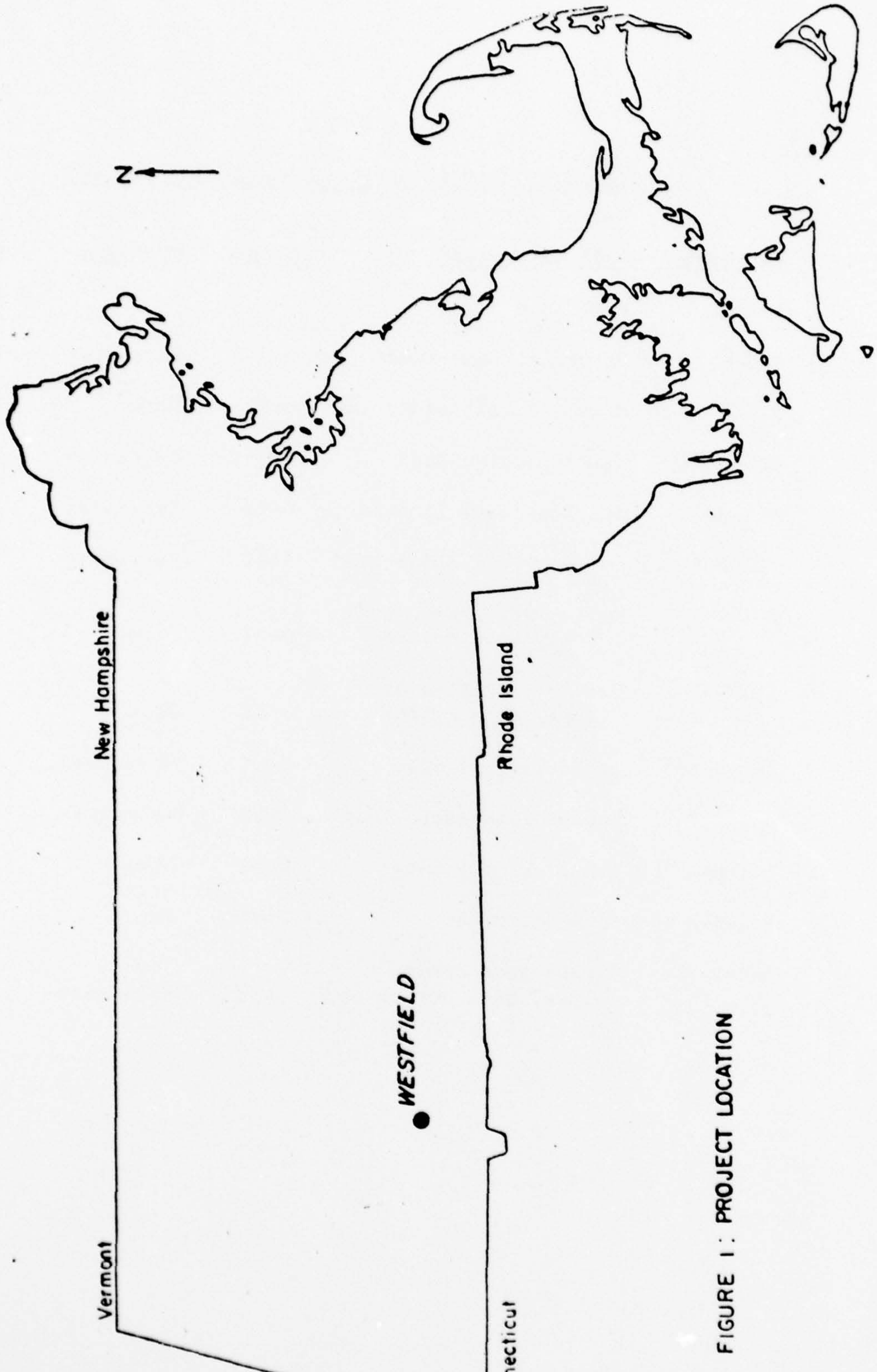


FIGURE 1: PROJECT LOCATION

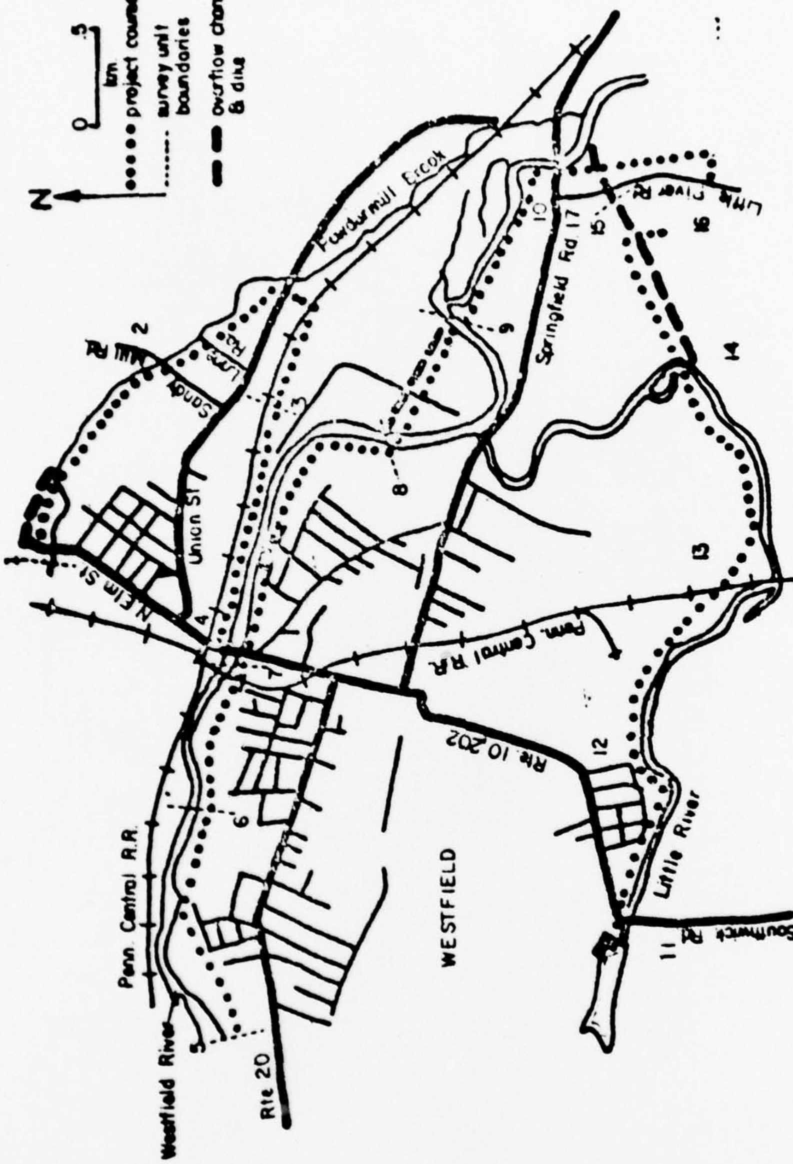


FIGURE 2 PROJECT MAP

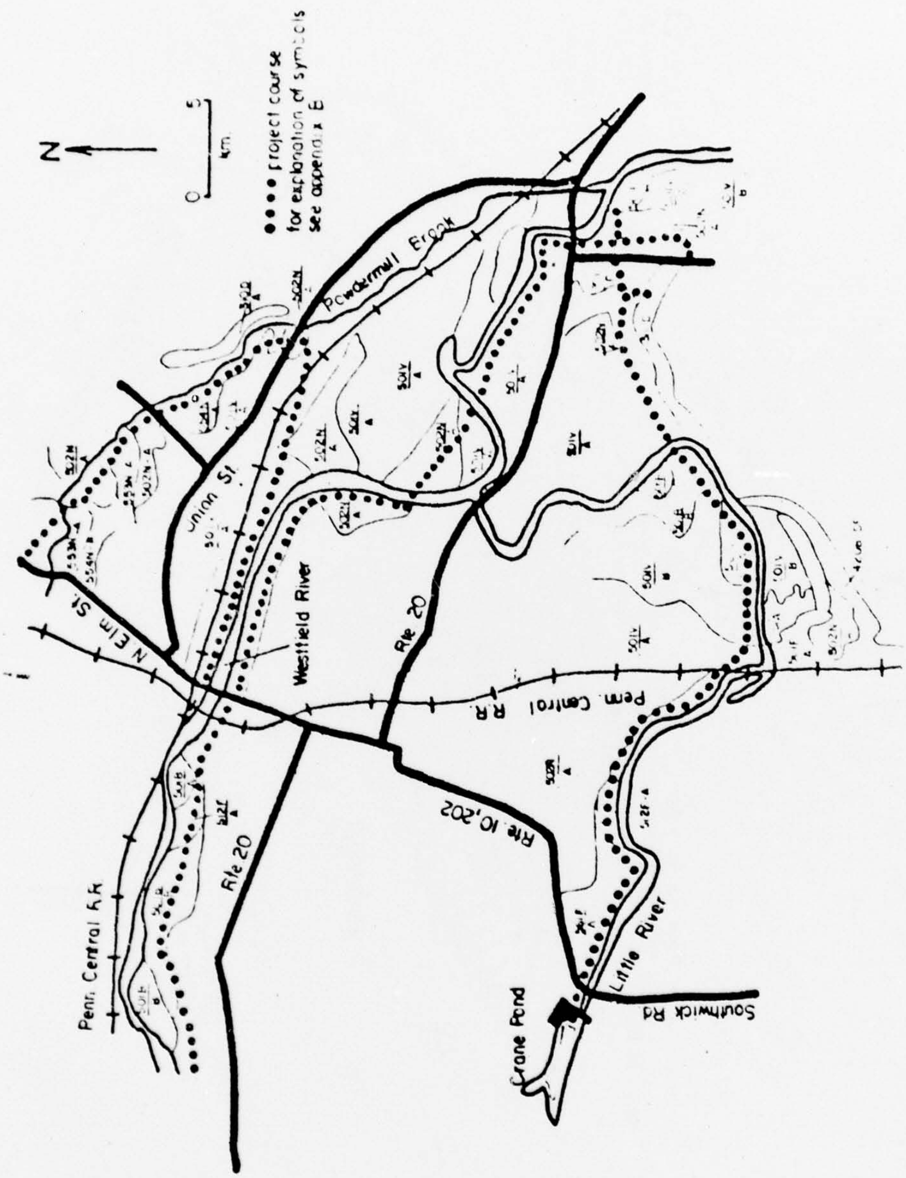


FIGURE 3 WESTFIELD LOCAL PROTECTION PROJECT, SOILS